Gpredict User Manual

Work in progress for Gpredict 2.x

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Revision History

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1 Introduction

1.1 What is Gpredict?

Gpredict is a real-time satellite tracking and orbit prediction program. A satellite tracking program is a computer program that predicts the position and velocity of a satellite at a given time, using a mathematical model of the orbit. Once the position and velocity of the satellite is known, other data can be calculated, ie. bearing, distance, footprint, and visibility. Figure 1.1 shows a diagram of the core functionality of a satellite tracking program.
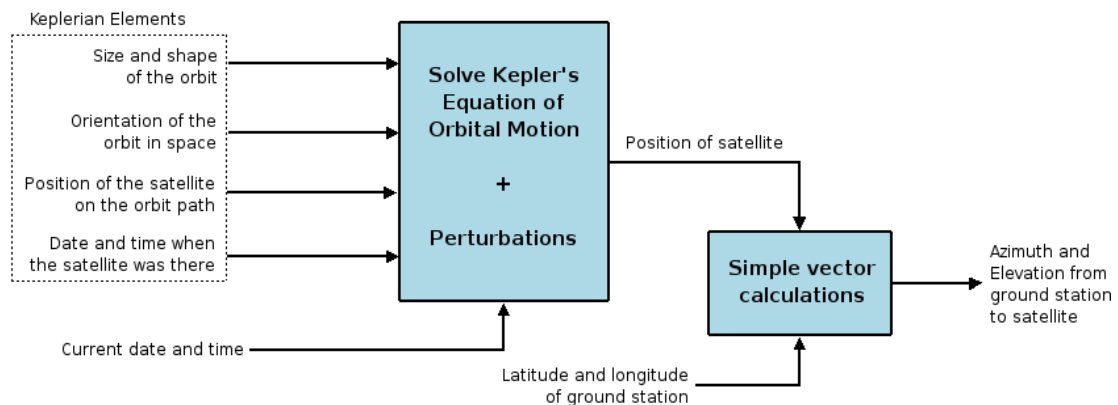
Figure 1.1: Functional overview of a satellite tracking program.

Gpredict, like any other satellite tracking program, takes three kinds of input:

1. Keplerian Elements describing the satellite orbit, as well as the position and velocity of the satellite at a given time t_0.

2. Position of the ground station on Earth.

3. The date and time at which the satellite position and velocity should be calculated.

Given the data above, Gpredict calculates the position and velocity of any Earth orbiting satellite using the NORAD SGP4/SDP4 algorithms. These algorithms solve Kepler's equation of orbital motion and apply various corrections to compensate for irregular effects like the shape of Earth and gravitational influence from other celestial bodies.

Gpredict has several ways of presenting the calculated satellite data to the user. It can show the position, footprint (i.e. coverage area), and ground track of the satellites on maps, it can show detailed satellite data in tables, and it can also show the satellites within range on a polar plot (radar screen).

The next section gives an overview of the features and functionality of Gpredict.

1.2 Features of Gpredict

- Fast and accurate real-time satellite tracking using the NORAD SGP4/SDP4 algorithms.

- No software limit on the number of satellites or ground stations.

- Nice presentation of the satellite data using maps, tables and polar plots (radar views).

- Allows you to group satellites into modules, each module having its own visual layout, and being customisable on its own. Of course, you can use several modules at the same time.

- Efficient and detailed predictions of future satellite passes. Prediction parameters and conditions can be fine-tuned by the user to allow both general and very specialised predictions.

- Allows you to track satellites in real time, simulated real time or manual time control.

- Exhaustive configuration options allowing advanced users to customise both the functionality and look & feel of the program.

- Automatic updates of the Keplerian elements from the web via HTTP and FTP, or from local files.

- Support for automated ground station operation providing both Doppler tuning for radios and antenna rotator control.

- Robust design and multi-platform implementation integrates Gpredict well into modern computer desktop environments, including Linux, BSD, Windows, and Mac OS X.

- Free software licensed under the terms and conditions of the GNU General Public License allowing you to freely use it, learn from it, modify it, and re-distribute it.

1.3 About this Document

This document is intended to give a complete description of all the functionalities in Gpredict as seen from a user's perspective.

- **Chapter 2** gives a quick introduction to the core functions and features in Gpredict. It introduces the concept of modules and views, which are the key objects in Gpredict. Reading this chapter should make users able to perform real-time satellite tracking and some basic orbit predictions using Gpredict.

- **Chapter 3** describes the top-level configuration options that allow users to customise the overall behaviour of Gpredict.

- **Chapter 4** gives a more in-depth description of the modules and the views. It also describes how to customise each individual module.

- **Chapter 5** describes the pass prediction functions in Gpredict including the pass condition parameters used by the prediction engine.

- **Chapter 6** describes how you can update the Keplerian elements for the

satellites in the Gpredict database.

- **Chapter 7** describes how to setup and operate Gpredict with your radios and antenna rotators.

1.4 Your Feedback is Appreciated

Both Gpredict and this user manual is work in progress. Your comments, questions and bug reports are highly appreciated. There is an IRC channel #gpredict on Freenode and a web forum at https://community.libre.space/c/gpredict where you can discuss everything related to Gpredict and ask the community for help.

The Gpredict website accessible at http://gpredict.oz9aec.net has more information about other ways you can get support with your problems, or how you can get in touch with the developers (see under User Support).

2 Getting Started with Gpredict

2.1 The Basic Idea

The key idea in Gpredict is the concept of **modules**. A module in Gpredict is the same as a document in a word processor application. It is an object, which has a certain number of satellites and a ground station associated to it. Based on the geographical location of the ground station and the current time, the module calculates the positions and other data for the satellites and displays it using various views organised in a layout.
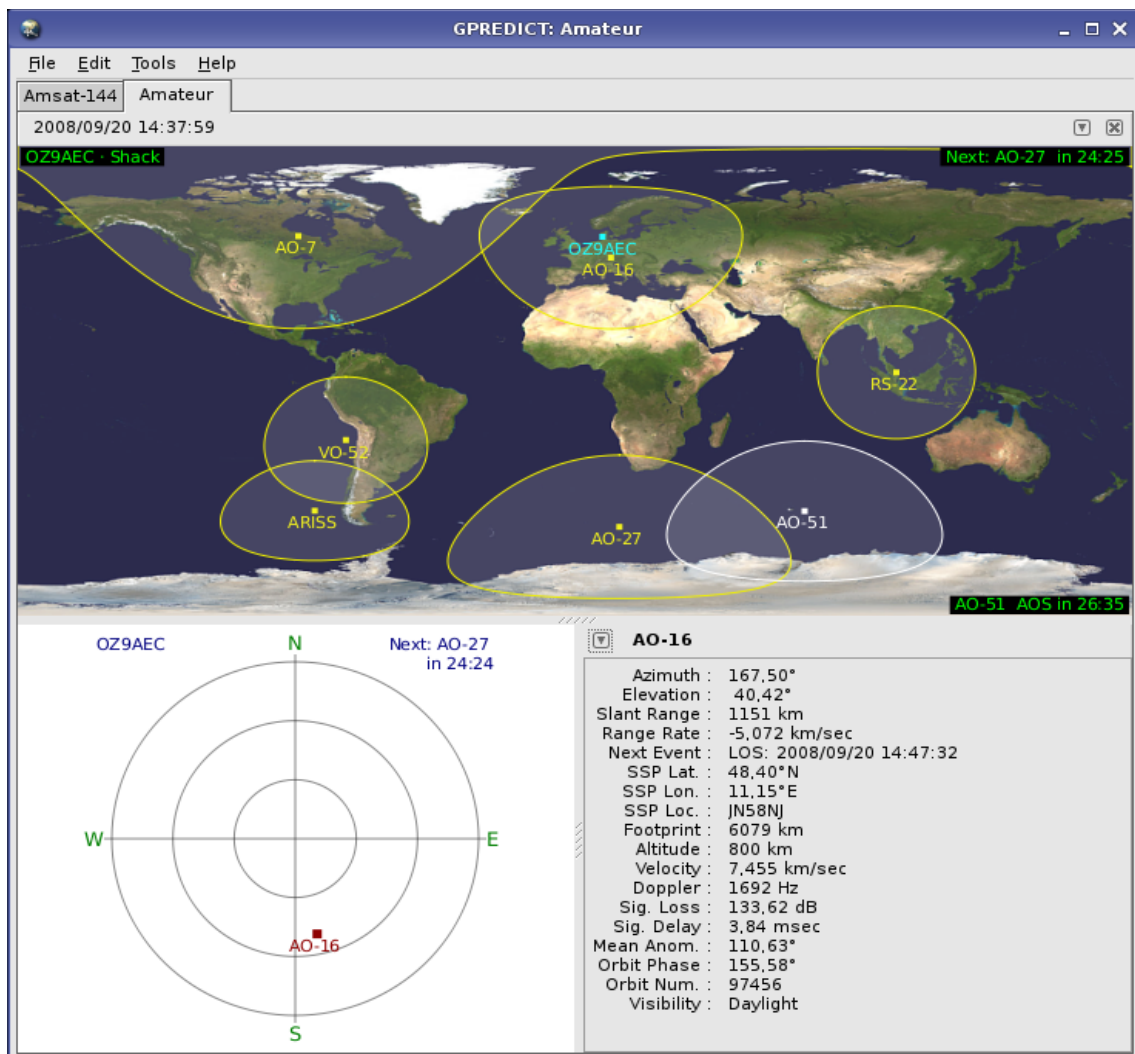
Figure 2.1: The default main window showing a module with three views.

When you start Gpredict for the first time it opens a module called Amateur. This module has a layout with three different views: A map view, a polar view and a single-sat view see figure 2.1. Currently four different views are available in Gpredict:

- **The List View** shows the satellite data in a list/table having one satellite in each row. It is well suited to present detailed information about many satellites at the same time. The rows in the list view are sorted automatically at run-time according to the selected sorting criteria (e.g. elevation, next event, etc.).

- **The Map View** shows the satellites and their footprints (coverage area) on a rectangular map. It is intended to give a quick overview of which satellite is where at a given time. The map view can also show the ground track of the satellites for several orbits.

- **The Polar View**, or radar view, shows the satellites within range on a polar plot. The polar axis corresponds to the azimuth and the radial axis to the elevation. It can be used to give you an idea of where to "look" for a satellite.

- **The Single-Satellite View** can very efficiently show detailed information about one single satellite. Its advantage over the list view is that it is much more efficient, since it only shows one single satellite.

- **The Upcoming Passes View** shows a list of satellites with a countdown till next AOS/LOS for each satellite.

The module organises the views using a layout. The layout is based on a two dimensional grid where data views (map, table, etc.) are placed by specifying type and coordinates. Figure 2.2 shows the 2x2 grid used in the default module.
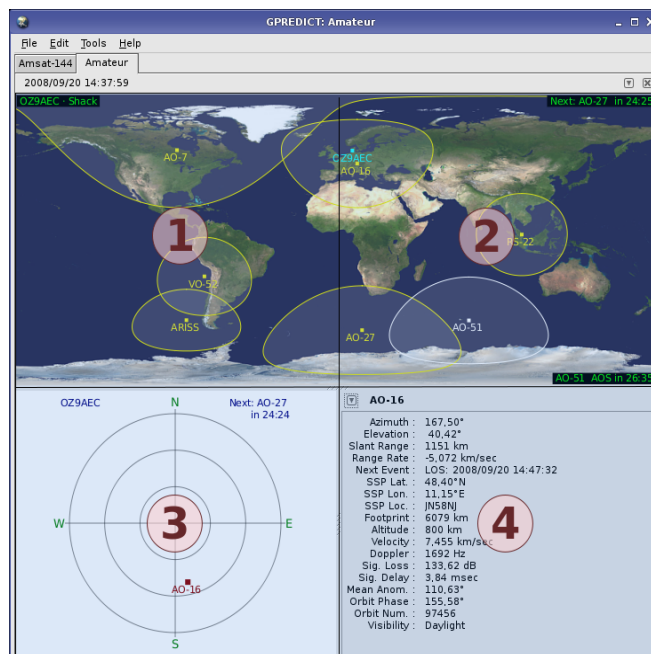
Figure 2.2: The four different layouts in Gpredict.

Section 2.3.3 will give you a more detailed description of data views in predefined layouts and chapter 8 describes how to create custom layouts.

2.2 The Module Pop-Up Menu

Each module has its own pop-up menu, which can be accessed by clicking on the **V** icon in the top right corner of the module. This pop-up menu gives you quick access to the functions that are relevant for a module. A screen shot of the pop-up menu is shown on figure 2.3.

The first two items in this pop-up menu are used to change the display state of the module. A module can be in three different states:

- **Docked:** In this default state the module is docked into the notebook in the main window.

- **Window:** In this state the module is put in its own window.

- **Full-screen:** In this state the module occupies the whole screen.

You can freely toggle between these three states at any time. Go ahead and try them if you haven't already done so.

Select satellite item allows you to select a satellite in all the open views. It opens another menu of all the satellites in the current module. Picking the satellite in that menu selects it in all the open views.

Figure 2.3: The module pop-up.

The next entry in the pop-up menu is **Sky at a glance**. This function is intended to give you a quick overview of which satellites are up now and which satellites will be up during the next 8 hours. This function is described in section 2.5.

The **Time controller** menu item pops up a small window (see figure 2.4) containing widgets for controlling the time of the module. By default, the module will run in real-time, but using the **Time controller** you have the possibility to tun in simulated real-time or manual time control.

The horizontal slider below the calendar allows you to quickly pan back and forward in time ± 2.5 hours from the current time.
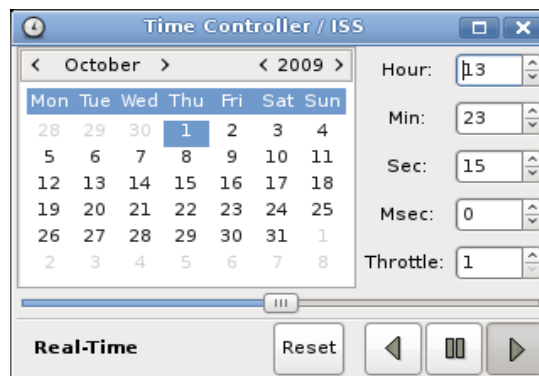
Figure 2.4: The time controller window.

The arrow buttons in the time controller determine in which direction the time should run. The **Throttle** value determines the *time compression factor*. A throttle value of 1 corresponds to 1 second / second (real-time), a value of 2 corresponds to 2 seconds / second (simulated real-time), etc. The **Pause** button between the two arrow buttons stops automatic increment of time and you can set the module time using the date and time controls in the window. The **Reset** button will reset the time to the current time provided by the operating system.

The **Radio Control** and **Antenna Control** menu items bring up the radio and antenna rotator controller windows. Setting up Gpredict to perform Doppler tuning of radios and antenna rotator tracking is described in details in chapter 7.

The **Configure** item allows you to customise the module. This function is described in the next section.

The **Clone...** menu item is a convenience function to create an exact copy of a module. If you select it a small dialogue window pops up asking you to enter a name for the new module. Enter an appropriate name. Note that only standard ASCII characters consisting of 0..9, a..z, A..Z, hyphen (-) and underscore (_) are allowed. This is because the name of the module is also used for naming the data file in which the configuration will be stored. If you clear the check box asking whether to open the module, the new module will be created and that's it. If you leave the check box checked, the new module will be opened right after it is created. Leave the check box checked and press OK.

You should see your new module appear in the notebook as a new page. A key feature in Gpredict is that you are allowed to use several modules at the same time. There is no limit on the number of open modules, except the processing power and available memory of your computer. It is also up to you how many modules should be docked in the notebook and how many should be in their own window. Needless to say, only one module can be in full-screen state at the same time.

The last two menu items in the pop-up menu, **Delete** and **Close**, do exactly what they promise. If you select **Delete** the module will be closed immediately and you will be prompted to confirm the deletion. This is your last chance before the module is completely removed from the disk.

A module can also be closed by clicking on the **X** icon in the top right corner.

2.3 Configuring the Module

If you have followed the cloning instructions in the previous section, you now have two copies of the same module. Lets modify one of them so that they are not exactly identical. Gpredict offers you the possibility to configure each module independently of the others. This is not a requirement, it is an option. It is up to you whether you want to use the global defaults or whether you want to customise each module to suit your needs, and this applies to all parameters.

To configure a module select the **Configure** menu item in the module pop-up menu. This will bring up a small dialogue window showing the module name, the name of the ground station, and which satellites are tracked in this module. Figure 2.5 shows a screen shot of the module configuration   window.

Note that you can not change the name of a module here. If you want to rename a module, create a clone and then delete the original.
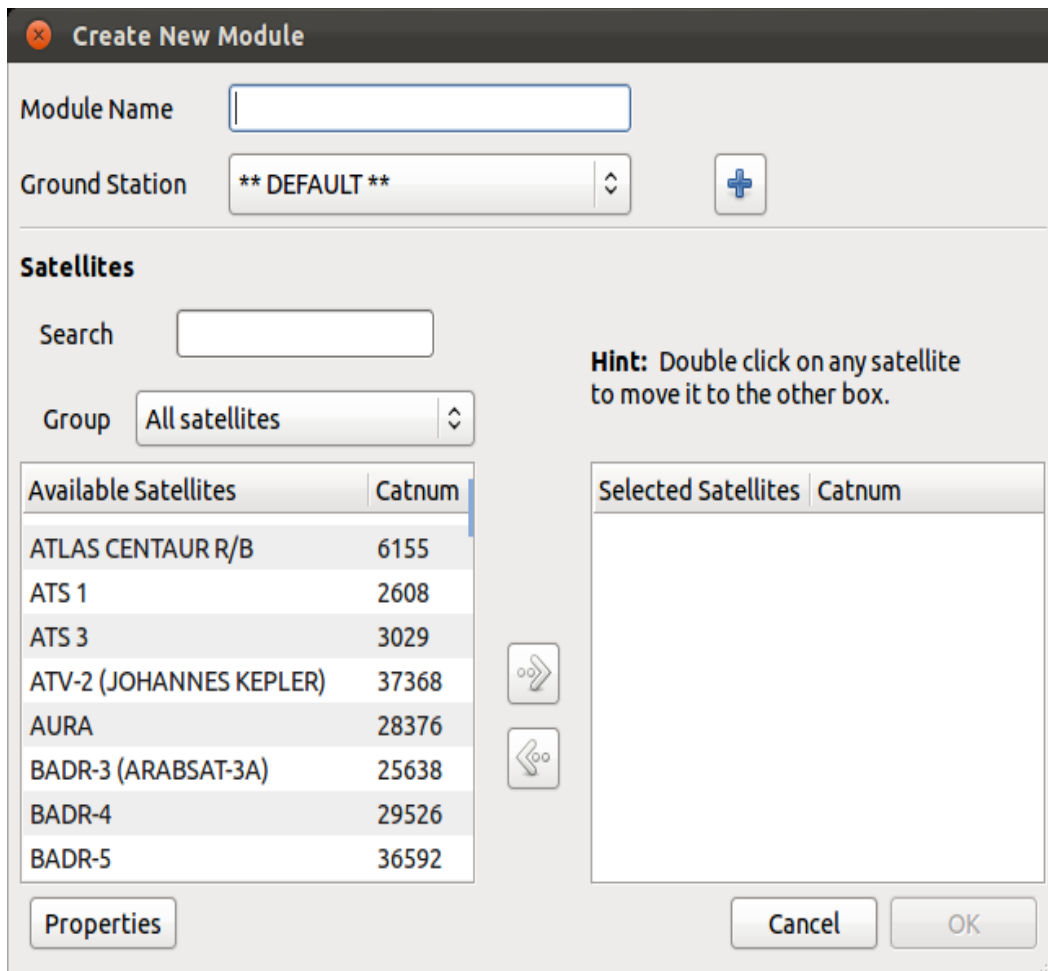
Figure 2.5: The module configuration window.

2.3.1 Setting Up the Ground Station

Below the module name you will find the name of the ground station, i.e. the geographical location that is used as reference point in the calculations. It is important to define the position of the ground station accurately since this it is one of the key input parameters in Gpredict. The sample module uses a ground station called *sample*, which defines a place in Denmark.

To add your own ground station, click on the **+** button located right of the ground station name. This should pop up a small dialogue window as shown on figure 2.6 where you can enter the data for your ground station. The only required parameter here is the **Name**, which you have to enter according to the same rules as the module name. Optionally, you can also enter a **Description** and the **Location** name, the latter could be a combination of the city and the country of the location.
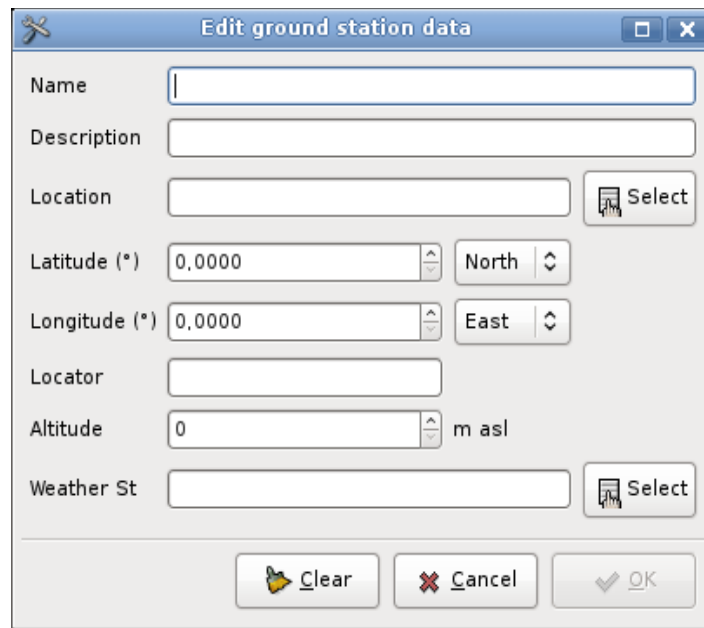
Figure 2.6: The ground station editor window

For your convenience Gpredict offers you the possibility to select a location from a predefined list. The list can be accessed via the **Select** button right next to the **Location** field. This is useful if you have no idea of the geographical coordinates of your location. In that case you can simply select the nearest city from the list.

Instead of entering the latitude and longitude of your location, you can also enter the Maidenhead locator grid square in the **Locator** field. Doing so will automatically update the latitude and longitude fields.

If your installation includes GPSD support, Gpredict allows you to configure the gpsd interface. Figure 2.7 shows the interface. You set **QTH Type** to GPSD and enter the **GPSD Server** and **GPSD Port**. For a gps receiver attached to current machine, a server of 127.0.0.1 and a port of 2947 are defaults. More information on gpsd is available at http://www.catb.org/gpsd. When gps is not available, the QTH is shown at the location as set above.

Figure 2.7: The ground station editor window when GPSD support is available.

When you are done, click **OK** to return to the module configuration. Your newly created ground station should be selected as location for this module.

2.3.2 Selecting the Satellites

Next step in the module configuration is to select which satellites should be tracked in this module.

The satellites currently tracked by this module are listed in the right side of the configuration window while the available satellites that can be tracked are listed on the left side of the window. You can move a satellite from one list to the other by double-clicking on it or by clicking on the arrow buttons between the two lists.

Gpredict has approximately 1200 satellites in its database that you can choose from. This selection of satellites includes those in the SATNOGS database, located at http://db.satnogs.org. To help you locate a specific satellite, you can use the **Search** field as well as the **Group** filter located above the list of available satellites. When you start typing a satellite name I the **Search** field, Gpredict will search as you type and highlight the satellite that matches your search.

The search is case insensitive.

> You should be careful not to select too many satellites for one module, otherwise your module may become clumsy. Too many satellites may also decrease the performance in particular if you are using a map view. Up to 10-15 satellites per module seems to be a good number, maybe less if you use the map view.

2.3.3 Module Properties

In order to edit the look and feel of the module click on the **Properties** button. This will bring up a window showing the module properties grouped in a notebook. Figure 2.8 below shows a screen capture of the module properties editor.
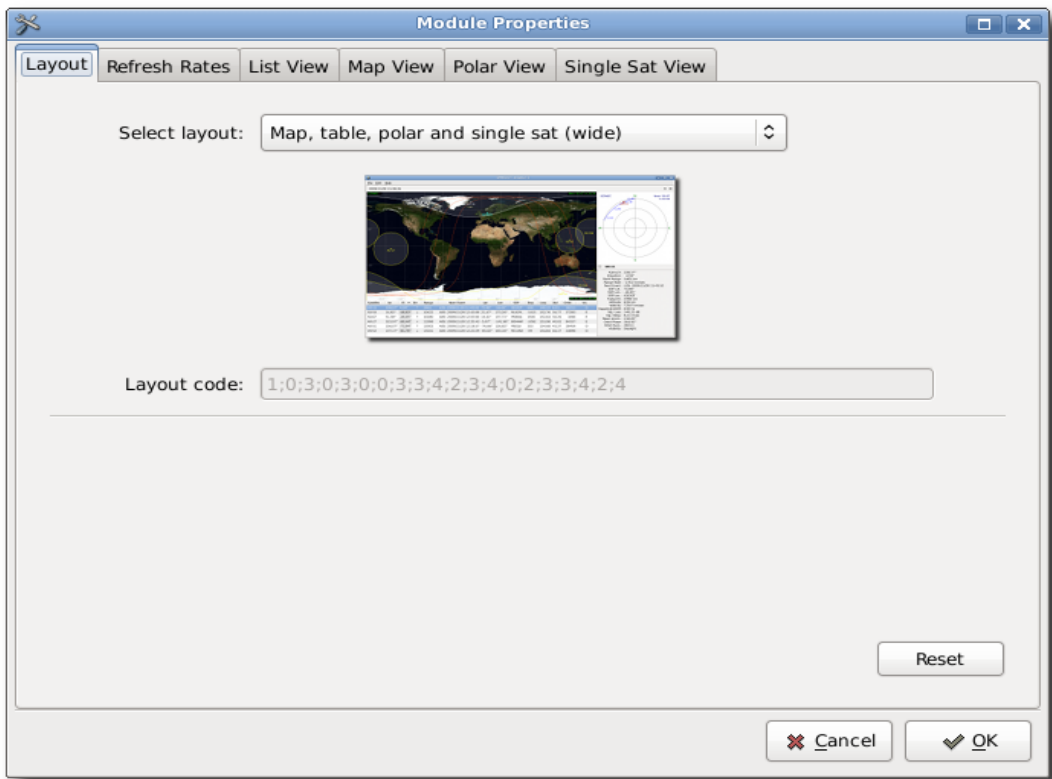
Figure 2.8: The module properties editor.

The **Layout** page allows you configure the visual appearance of the module. You can choose between nine predefined layouts or create your own custom layout by specifying the layout code. The different views are explained in greater detail in section 4.2 and a description of how to create your own layout is in chapter 8.

The **Refresh Rates** page allows you to tune how often the module should perform

the calculations, as well as how often the views should be updated. The data refresh rate is specified in milliseconds. This is the time between two calculation-cycles. Every cycle the module will recalculate the data for all satellites associated to the module. The refresh rates for the views are specified in integer cycles of data refresh. If the data refresh rate is 400 msec and the list view refresh rate is 2 cycles, the list view will be refreshed every 800 msec.

The map and the polar view do not need to be refreshed very often. For these views visible changes will normally occur over 3-4 seconds. The list and the single-satellite view, on the other hand, looks pretty cool when they are refreshed every 100-200 msec, **but be careful with the CPU load**, in particular if you have many modules open at the same time.

The rest of the pages in the module property editor define the look and feel of the views. Most of the parameters are self-explaining and you should not be afraid of experimenting with the different settings. If you somehow end up with a useless configuration, you can always reset to the default values by clicking on the **Reset** button that is available on all pages.

Chapter 4 describes the modules in more details and also gives a detailed description of the configuration parameters.

2.4 Creating a New Module

In order to create a new module, select **File → New Module** in the menu bar. This will bring up the same dialogue as you saw while customising an existing module in the previous section (see figure 2.5), except that here you have to enter a new name for the module.

Besides the name you will also need to select the observer location and the satellites you wish to track with the new module. Of course, you can also customise the new module as described in the previous section.

When you are finished, click **OK** and the new module will open in the notebook.

2.5 Predicting Satellite Passes

2.5.1 Upcoming Passes for a Satellite

In order to predict satellite passes occurring in the near future, you have to right-click on a satellite in any view. This brings up a pop-up menu for the selected satellite, and in this pop-up menu you can select either the **Show next pass** or the **Future passes** menu item. If the Satellite is above the horizon, you can select **Show Current Pass**. Figure 2.9 shows how the satellite pop-up menu looks like when you right click on a satellite in the map view. The satellite popup for other views look slightly different; however, there will always be two menu items for predicting the upcoming passes.

Figure 2.9: Satellite popup.

The **Show next pass** function gives you detailed information on the first coming pass including the azimuth, elevation, range and footprint during the course of the pass. The data is shown in a table as well as on a polar and an Az/El plot, see figure 2.10. You can configure Gpredict to show other data in this dialogue, select **Edit → Preferences** and go to the **Predict → Single Pass** page. Section 5.1 contains more details on how to customise and fine-tune the future pass prediction engine.

Show Current Pass behaves the same as **Show next pass**.
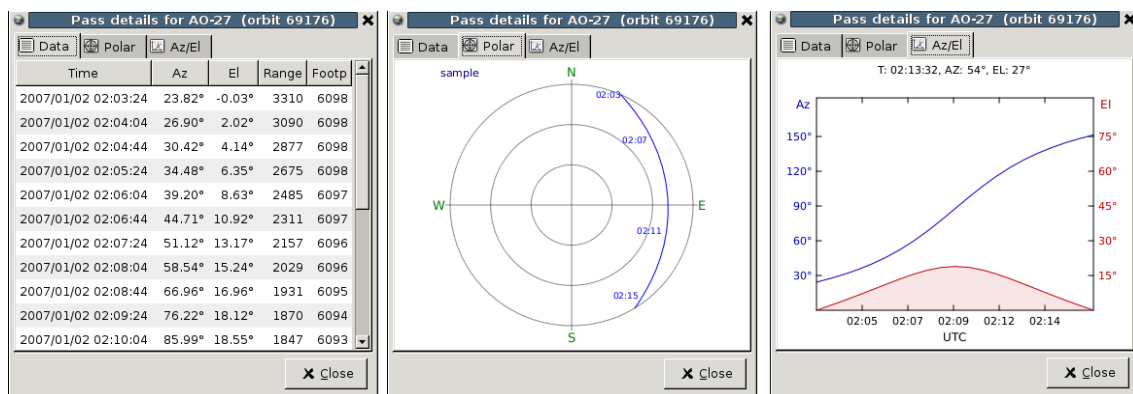
Figure 2.10: Data presented about the next upcoming pass.

The **Future passes** function gives you an overview of up to the next 10 passes occurring within the next 3 days. The information you are given is the rise time (AOS), the set time (LOS), the duration, maximum elevation and the azimuth at AOS and LOS. Again, all parameters including the number of passes to predict can be customised via the **Preferences** dialogue.

If you double-click on a row in the **Future passes** dialogue, a new window pops up showing the details for the pass you have clicked on. This is the same window as you saw when you selected the **Show next pass** function, but the pass details are now for the selected pass in the future, which is not necessarily the first coming pass.

The data displayed in the pass prediction dialogues is static. This means that the shown data will not be updated automatically if you leave the dialogues open. You will have to request a new prediction as described above.

> You may have noticed that the above mentioned pop-up menu does not come up if you right-click in the single-satellite view. To bring up the pop-up menu in the single-satellite view you should click on the **V** icon right next to the satellite name.

2.5.2 The Sky at a Glance

The sky at a glance is a convenience function in Gpredict that can show you a quick overview of what satellite passes you can expect at your location between now and the next X hours. An example is shown on Figure 2.11 below. You can activate this function via the module popup menu and there are more details about configuring this function in chapter 5 – Advanced Pass Predictions.
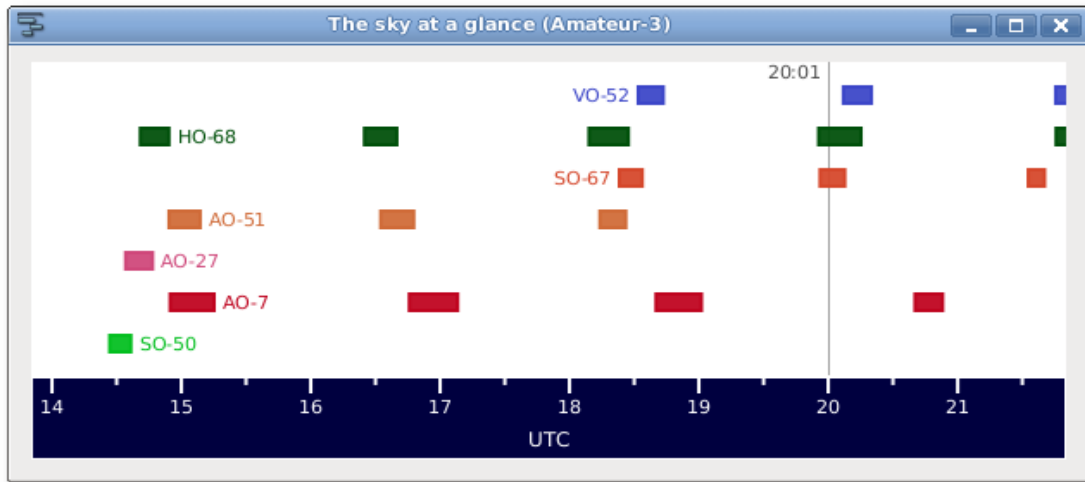
Figure 2.11: The sky at a glance.

2.6 Moving On

If you have read through this section carefully you should have a good understanding of the basic functions in Gpredict as well as some understanding of how they work. The following chapters of this manual will continue with more detailed descriptions of all functions in Gpredict, some of which have not been covered in this introductory section. Once you get used to the basic functionalities in Gpredict, you should definitely go on and read the rest of the manual, too. Have fun!

3 Customising Gpredict

3.1 Overview

On one hand, Gpredict tries to be very simple and easy to use not requiring any lengthy configuration and set-up procedures (runs out of the box). On the other hand, Gpredict tries to let the users customise the look and feel of the application down to the lowest details. Some people would say that these two requirements contradict one another, nevertheless, they have been the key drivers during the design and development of Gpredict.

Consequently, Gpredict has two customisation levels:

1. **The Global Settings** define the behaviour of Gpredict as a whole and also provide default values for the modules. These settings can be accessed from the main menu bar via the **Edit → Preferences** menu item.

2. **Module Level.** These settings allow the user to customise each module independently of the others. They are accessed via the pop-up menu of each module: **Configure → Properties**.

The preferences dialogue for editing the global settings is shown on figure 3.1. If you compare it with the module properties editor you saw in the previous chapter you will notice that the module properties dialogue is simply a subset of the global preferences dialogue. In other words, the global configuration dialogue contains the module properties dialogue, and the settings in the global preferences dialogue provide the default values for modules, where there are no specific user settings.
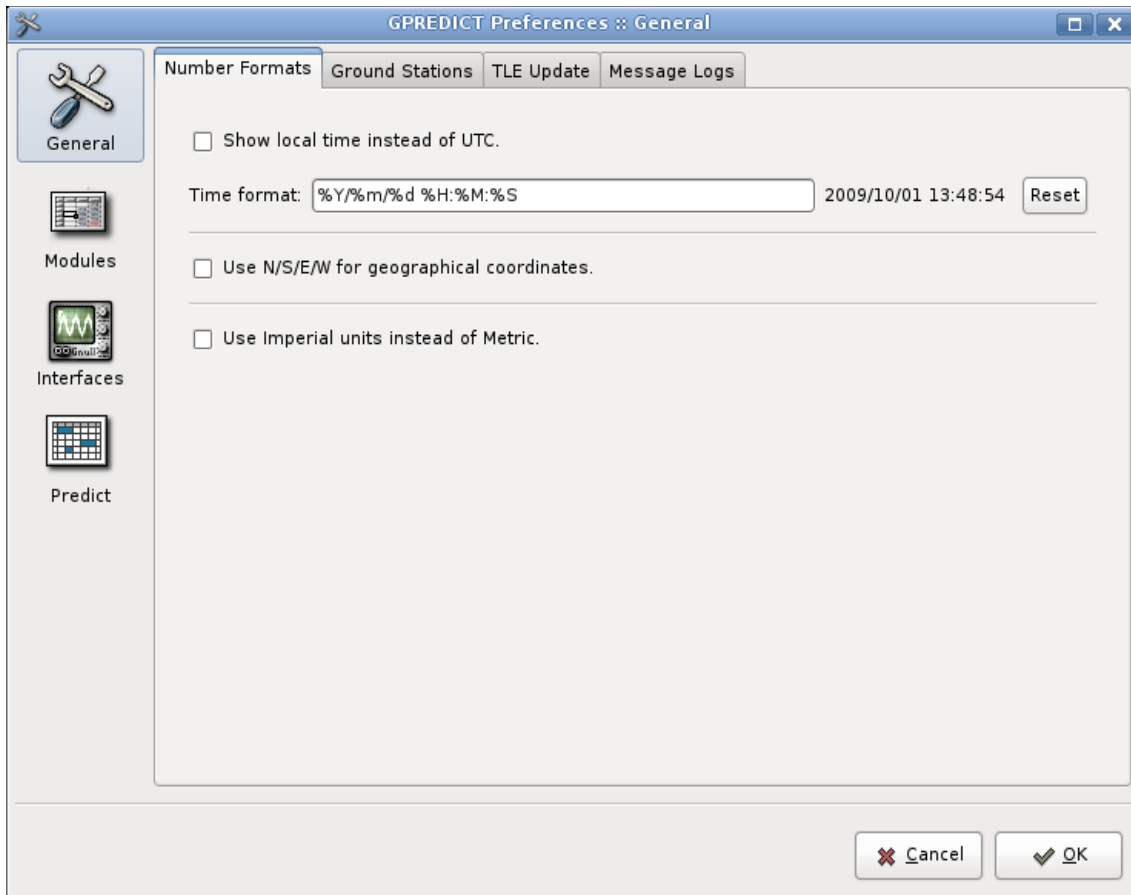
Figure 3.1: The preferences dialogue.

The global preferences are divided into four major groups:

1. **General:** This group contains global parameters that influence the overall behaviour of the application, for example the way numbers are displayed.

2. **Modules:** The parameters in this group define the default settings and properties for the modules. This includes the module layout, refresh rates, and settings for the available views (map, list, polar, and single-sat). The parameters are described in details in chapter 4, where a thorough description of the functionality of the modules is given.

3. **Interfaces:** Settings for automating radio and antenna rotator control. The set-up and use of this feature is described in details in chapter 7.

4. **Predict:** Parameters that define the functional and visual behaviour of the future pass prediction functions. These are described in chapter 5.

The rest of this chapter describes the parameters in the *General* group, page by page. You can freely experiment with the configuration parameters without worrying too much about messing up your settings. Gpredict offers you a **Reset to Default** function for most parameters. This function can be accessed via the **Reset** button available everywhere in the configuration dialogue.

3.2 Number Formats

These settings determine how numbers are displayed in Gpredict. They can be accessed from the menu bar via **Edit → Preferences → General → Number Formats**. Figure 3.1 shows how the configuration page looks like in the dialogue.

3.2.1 Show Local Time Instead of UTC

By default, Gpredict shows the time and date in UTC (Universal Time Coordinates). If you check this box Gpredict will show the Local Time instead of UTC. Please note that Local Time is the time according to the locale settings in your operating system, which is not necessarily the same as the local time at the selected ground station.

3.2.2 Time Format

This parameter offers you a very flexible way to define how the date and time should be displayed throughout the program. The time format is specified using a format string consisting of any combination of characters and format codes. The most commonly used format codes are listed in table 3.1, while table 3.2 lists the less common codes. The label next to the format string entry box shows how the date and time will be displayed using the soecified format string. This label is updated continuously as you type into the format string entry box.

Table 3.3 gives a few examples on how the time format codes can be used to create time format strings. You are highly encouraged to experiment for yourself, and use the Reset button to reset the format string to the factory default setting if something goes wrong.

Code	Description
%a	The abbreviated weekday name according to the current locale.
%A	The abbreviated month name according to the current locale.
%B	The full month name according to the current locale.
%c	The preferred calendar time representation for the current locale.
%d	The day of the month as a decimal number (range 01 to 31).
%e	The day of the month padded with blank (range 1 to 31).
%F	The date using the format \%Y-\%m-\%d.
%H	The hour as a decimal number (range 00 to 23).
%m	The month as a decimal number (range 01 to 12).
%M	The minute as a decimal number (range 00 to 59).
%S	The seconds as a decimal number (range 00 through 60).
%z	Numeric time zone (e.g., -0600 or +0100).
%Z	The abbreviated time zone (e.g. CEST or GMT).

Table 3.1: Most common format codes

Code	Description
%C	The century of the year.
%D	The date using the format %m/%d/%y.
%g	The year corresponding to the ISO week number, but without the century (range 00 through 99).
%G	The year corresponding to the ISO week number. Similar to %Y.
%h	The abbreviated month name. The action is the same as for %b.
%I	The hour as a decimal number (range 01 to 12).
%j	The day of the year (range 001 to 366).
%k	The hour as a decimal number, like %H, but padded with blank (range 0 to 23).
%l	The hour as a decimal number, like %I, but padded with blank (range 1 to 12).
%n	A single \n (newline) character. Use with care.
%p	Either AM or PM, according to the given time value (not supported in all locales).
%P	Either am or pm, according to the given time value (not supported in all locales).
%r	The complete calendar time using the AM/PM format of the current locale. This format is equivalent to %I:%M:%S %p.
%R	The hour and minute in decimal numbers using the format %H:%M.
%s	The number of seconds since the epoch, i.e., since 1970-01-01 00:00:00 UTC. Leap seconds are not counted unless leap second support is available.
%t	A single \t (tabulator) character.
%T	The time of day using decimal numbers using the format %H:%M:%S.
%u	The day of the week as a decimal number (range 1 through 7), Monday being 1.
%U	The week number of the current year as a decimal number (range 00 to 53), starting with the first Sunday as the first day of the first week.
%V	The ISO week number (range 01 to 53). ISO weeks start with Monday.
%w	The day of the week (range 0 to 6), Sunday being 0.
%W	The week number of the current year (range 00 to 53), starting with the first Monday as the first day of the first week.
%x	The preferred date representation for the current locale.
%X	The preferred time of day representation for the current locale.
%y	The year without a century as a decimal number (range 00 through 99).
%Y	The year as a decimal number, using the Gregorian calendar.
%%	A % sign.
text	You can use any free text and characters.

Table 3.2: The not so common time format codes.

Format String	Resulting Time String
%Y/%m/%d %H:%M:%S	2006/07/23 21:22:00
%Y.%j %H:%M:%S	2006.204 21:22:00
%b %d, %Hh%M	Jul 23, 21h26

Table 3.3: Examples of time format strings.

3.2.3 Geographical Coordinates

Geographical coordinates in Gpredict (e.g. ground station location and sub-satellite points) are specified using decimal degrees North for latitude and decimal degrees East for longitude. This means that longitudes West of Greenwich are negative, as are latitudes South of the Equator. To avoid any endless discussions on whether this is the correct convention or not, Gpredict offers you the possibility to show geographical coordinates using N, S, E and W suffixes instead of signs. You can enable this by checking the **Use N/S/E/W for geographical coordinates** field. Enabling this will show 12.34° East of Greenwich as 12.34°E, while 12.34° West of Greenwich will be shown as 12.34°W.

3.2.4 Measurement Units

This option allows you to choose imperial units instead of the metric system, i.e. miles instead of km and feet instead of meters. Internally, Gpredict will always use the metric system and this setting will only affect how the data is presented.

3.3 Ground Stations

This page allows you to add, edit and delete ground stations. You can define as many ground stations as you want, but you need at least one. You can always choose between the pre-defined ground stations when you create or configure a module. Figure 3.2 shows how the corresponding configuration page looks like in the preferences dialogue.

The page shows the existing ground stations in a table. For each entry, the table shows the name, latitude, longitude, altitude, weather station, and whether the ground station is the default one or not[1]. If gpsd support is enabled, it also shows the GPSD server, GPSD port, and QTH Type. The table also shows a column called QRA. This is the Maidenhead locator square corresponding to the specified location. Gpredict does not store the Maidenhead locator info, instead it calculates it automatically from the latitude and longitude.

Below the table there are three buttons, namely **Add New**, **Edit**, and **Delete**. As their names suggest, these buttons are there for adding, editing and for deleting entries in the table.

---

1 Default ground station has no particular meaning in Gpredict, except that this location will be used when no explicit selection is made for a module or prediction function
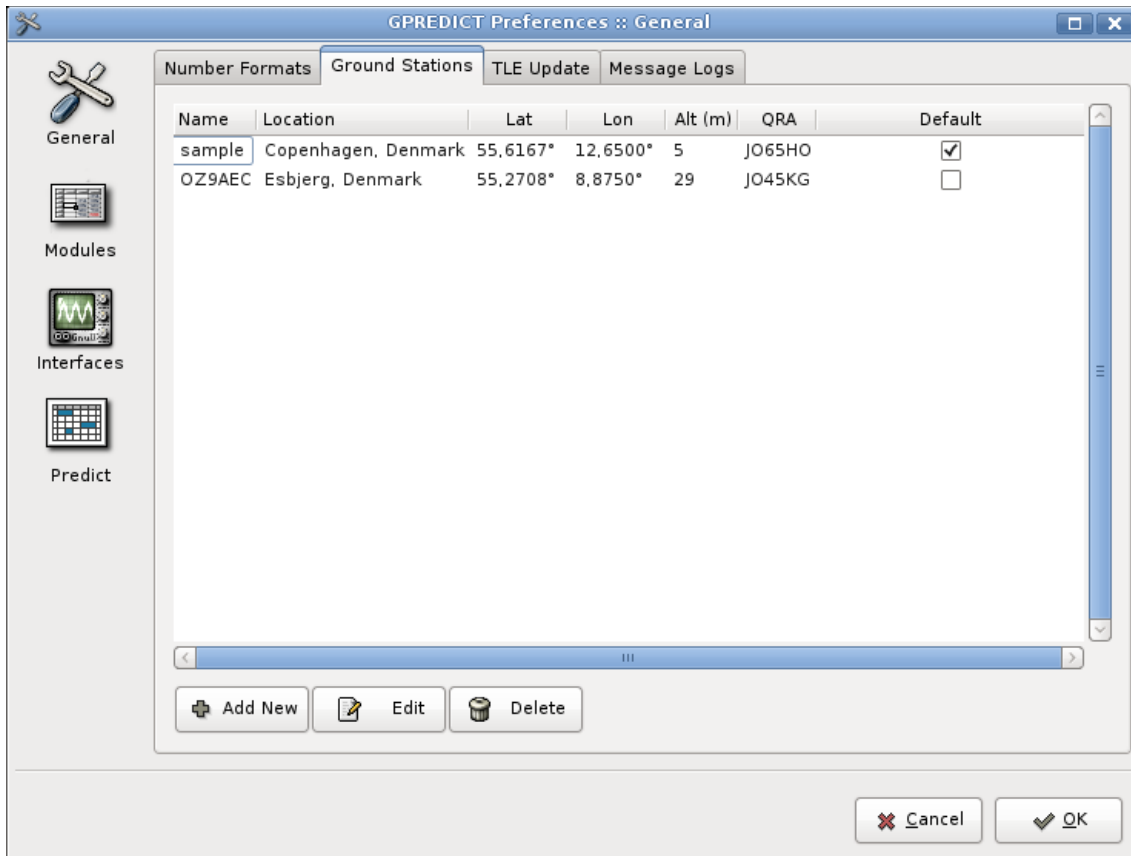
Figure 3.2: The table showing the existing ground stations.

To add a new ground station click on the **Add New** button. This will bring up the dialogue shown on figure 2.6 with all fields initially empty. You can proceed by doing the following:

1. Enter a short name for the ground station using the characters a..z, A..Z, 0..9, hyphen and underscore. This name will also be used as file name and it must be unique[2].

2. Enter the coordinates by either:

   o Manually entering the latitude and longitude or

   o Entering the Maidenhead locator square or

   o Selecting a location from the built-in list. Click the **Select** button right next to the Location field to get a list of major cities around the World.

1. If you wish, you can fill out the optional fields, too:

   o Description.

   o Location.

   o Altitude.

   o Weather station.

---

2 If you enter the name of an existing observer the data will be overwritten with no further warnings.

Clicking on the **Edit** button will bring up the same dialogue as when clicking on the **Add New** button, but the fields will be filled out with the values from the selected ground station. The ground station editor behaves in exactly the same way as when you add a new location.

If you click on the **Delete** button, the selected entry will be removed from the table immediately. The data will still exist on the disk and will only be erased when you commit your changes, i.e. when you press the **OK** button. If you delete an entry by mistake, you can always bail out using the **Cancel** button. This, however, will also cancel any other modifications you may have made during this session.

3.4 TLE Update

In order to make accurate calculations, Gpredict needs up to date Keplerian Elements (TLE data) for the satellites. These data can be updated from the Internet, and Gpredict can actually do most of the work for you. The settings on this configuration page allows you to configure how Gpredict should manage the update of the TLE files. Most of the settings should be pretty self-explanatory, nevertheless they are described in details in chapter 6. Until then you can leave the values at their defaults.

3.5 Message Logs

Gpredict logs all run-time messages into log files for later examination in case of debugging and error tracing. The settings on this page allows you configure the logging level and whether old log files should be kept or deleted. For everyday use you should keep the default settings.

In case you want to examine the current log file while Gpredict is running select **Log browser** in the File menu. Besides showing the current messages the log browser will show a nice summary of the number of errors, warnings, info and debug messages.

4 Modules and Views

4.1 Data Fields

Table 4.1 provides a complete reference for what kind of data fields (i.e. satellite data) Gpredict can calculate, and which views and functions can show them to the user.

Data Field		List View	Map View	Polar View	Single Sat.	Predict dial.
Satellite Name	-	√	√	√	√	√
Catalogue Number	-	√				√
Azimuth	[°]	√		√	√	√
Elevation	[°]	√		√	√	√
Direction	-	√		√	√	
Right Ascension	[°][3]	√			√	√
Declination	[°]	√			√	√
Range	[km]	√			√	√
Range Rate	[km/s]	√			√	√
SSP Latitude	[°]	√	√		√	√
SSP Longitude	[°]	√	√		√	√
SSP Maidenhead Locator	-	√	√		√	√
Footprint	[km]	√	√		√	√
Ground Track	-		√			
Sky Track	-			√		
Altitude	[km]	√			√	√
Velocity	[km/s]	√			√	√
Doppler Shift (100 MHz)	[Hz]	√			√	√
Signal Loss	[dB]	√			√	√
Signal Delay	[ms]	√			√	√
Mean Anomaly	[°]	√			√	√

---

3 The right ascension can also be displayed in hh:mm:ss or hh:mm.mm format.

Data Field		Available in				
		List View	Map View	Polar View	Single Sat.	Predict dial.
Orbit Phase	[°]	√			√	√
Orbit Number					√	
Visibility	-	√			√	√
Ground Station Info	-		√	√		
Cursor Track	-		√	√		
Next Event (AOS or LOS)	[hms]	√	√	√	√	√
AOS	[hms]	√			√	√
LOS	[hms]	√	√	√	√	√
TCA	[hms]					√
Pass Duration	[hms]					√
Maximum Elevation	[°]					√
Azimuth at AOS/LOS	[°]					√

Table 4.1: Data field availability in the different views.

4.2 Views

4.2.1 The List View

The list view shows the data organised in a list/table. It shows one satellite per row and it is very efficient to show detailed information for many satellites at the same time. The list view shows all the satellites that are associated to its parent module. Figure 4.1 shows a screen capture of a list view.

By default the list view shows the name, azimuth, elevation, direction, range, time of next event (either AOS or LOS), altitude, and orbit number for the satellites. There are many more data columns available, they are just hidden by default. Table 4.1 on page 29 shows a full list of available data fields for the list view. To change the global defaults use the preferences dialogue; **Edit → Preferences → Modules → List View**, while the settings for each individual list view in a specific module can be changed via **Module Pop-Up → Configure → Properties → List View**.
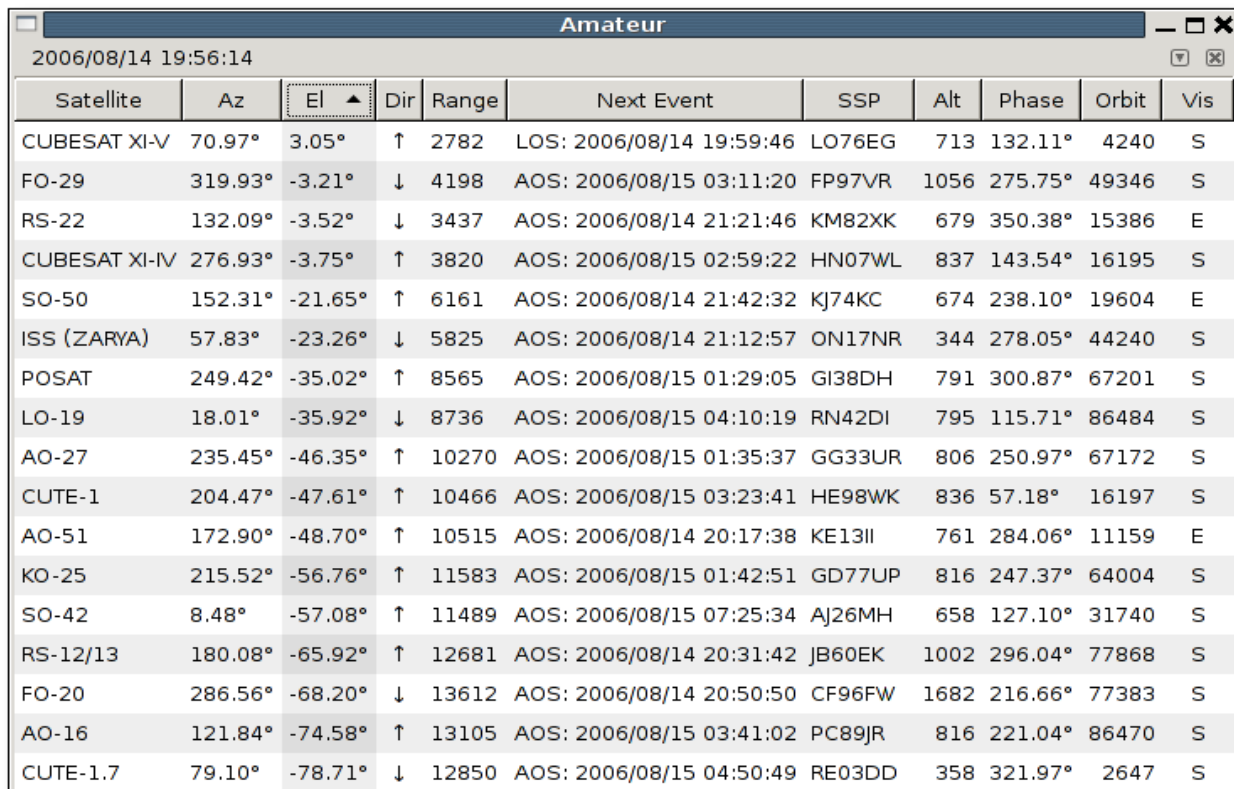
One of the more interesting features of the list view is its ability to dynamically sort the rows using any of the visible columns as sorting criteria, in both ascending and descending order. By default the list view is sorted in ascending order using the satellite names as criteria, that is the list is sorted in alphabetical order. To sort the list according to another column, you can simply click on the column header. You can reverse the sorting order by clicking on the same column header again. Note that the column that is used as sorting criteria is shaded differently than the other columns.

The list view on figure 4.1 is sorted by the elevation of the satellites and the small arrow in the column header pointing up indicates that the list is sorted in descending order. When the list is sorted in ascending order, the small arrow points down.

Right clicking on row in the list view brings up the satellite pop-up menu that gives you access to the following functions:

- **<SATELLITE NAME>:** Selecting this menu item brings up a small info window showing some static data about the satellite consisting of the Keplerian Elements.

- **Show Next Pass:** This will bring up the dialogue window showing the details about the next upcoming pass for this satellite.

- **Future Passes:** This will bring up the dialogue window showing the summary for the next N passes, N being a user configurable parameter (see section 5.1).

The list view has rather few configuration options. Besides the data fields described earlier, there is one more configuration parameter that should be mentioned, namely the **Enable Rules Hint in List Views** option. This option tells the theme engine of the desktop manager that the list view requires users to read across rows and associate cells with one another. By default, the theme engine will then render the list with alternating row colours making it easier to distinguish the rows (see figure 4.1). The exact behaviour depends on your desktop theme. This setting is only available in the global configuration dialogue and it applies to all list views in Gpredict.

Satellite	Az	El ▲	Dir	Range	Next Event	SSP	Alt	Phase	Orbit	Vis
CUBESAT XI-V	70.97°	3.05°	↑	2782	LOS: 2006/08/14 19:59:46	LO76EG	713	132.11°	4240	S
FO-29	319.93°	-3.21°	↓	4198	AOS: 2006/08/15 03:11:20	FP97VR	1056	275.75°	49346	S
RS-22	132.09°	-3.52°	↓	3437	AOS: 2006/08/14 21:21:46	KM82XK	679	350.38°	15386	E
CUBESAT XI-IV	276.93°	-3.75°	↑	3820	AOS: 2006/08/15 02:59:22	HN07WL	837	143.54°	16195	S
SO-50	152.31°	-21.65°	↑	6161	AOS: 2006/08/14 21:42:32	KJ74KC	674	238.10°	19604	E
ISS (ZARYA)	57.83°	-23.26°	↓	5825	AOS: 2006/08/14 21:12:57	ON17NR	344	278.05°	44240	S
POSAT	249.42°	-35.02°	↑	8565	AOS: 2006/08/15 01:29:05	GI38DH	791	300.87°	67201	S
LO-19	18.01°	-35.92°	↓	8736	AOS: 2006/08/15 04:10:19	RN42DI	795	115.71°	86484	S
AO-27	235.45°	-46.35°	↑	10270	AOS: 2006/08/15 01:35:37	GG33UR	806	250.97°	67172	S
CUTE-1	204.47°	-47.61°	↑	10466	AOS: 2006/08/15 03:23:41	HE98WK	836	57.18°	16197	S
AO-51	172.90°	-48.70°	↑	10515	AOS: 2006/08/14 20:17:38	KE13II	761	284.06°	11159	E
KO-25	215.52°	-56.76°	↑	11583	AOS: 2006/08/15 01:42:51	GD77UP	816	247.37°	64004	S
SO-42	8.48°	-57.08°	↑	11489	AOS: 2006/08/15 07:25:34	AJ26MH	658	127.10°	31740	S
RS-12/13	180.08°	-65.92°	↑	12681	AOS: 2006/08/14 20:31:42	JB60EK	1002	296.04°	77868	S
FO-20	286.56°	-68.20°	↓	13612	AOS: 2006/08/14 20:50:50	CF96FW	1682	216.66°	77383	S
AO-16	121.84°	-74.58°	↑	13105	AOS: 2006/08/15 03:41:02	PC89JR	816	221.04°	86470	S
CUTE-1.7	79.10°	-78.71°	↓	12850	AOS: 2006/08/15 04:50:49	RE03DD	358	321.97°	2647	S

Figure 4.1: The list view illustrating the auto-sort feature.

4.2.2 The Map View

The map view is intended to give you a quick overview of which satellite is where at any given time. The map view shows both the position of the satellites and their footprints. Moreover, the map view can also show information about the current ground station, the next event, i.e. which satellite comes up next, as well as information about the selected satellite.

Figure 4.2 shows how the map view looks like using the default settings. As you can see, the satellites are shown as small yellow squares with their name is printed just below the square[4]. The footprints of the satellites is drawn using the same colour as the satellite mark and label, and the area covered by the footprint is highlighted using transparent white colour.

The footprint of a satellite is the area on the surface of the Earth where the satellite is visible. On a sphere the footprint would be a circle, but since the map view projects the sphere to a rectangular surface the footprints will only look like a circle when the satellite is near the Equator.

As you can see on figure 4.2, satellite AO-51 is drawn in white instead of yellow. This means that AO-51 is selected. You can select a satellite by simply clicking on it with the left mouse button. You can click anywhere within its footprint area. The selected satellite will have its next AOS or LOS time shown in the lower right corner of the map view. Selecting a satellite will clear any other selection, that is you can have only one satellite selected at a time. You can also clear your selection by clicking once more on the selected satellite.

Each satellite has a pop-up menu associated to it. You can activate the pop-up menu by right clicking on a satellite. The pop-up menu is very similar to the one you have seen in section 4.2.1 for the list view, except that there are a few items only applicable for the map view. Following items are available in the satellite pop-up menu for the map view:

- **<SATELLITE NAME>:** Selecting this menu item brings up a small info window showing some static data about the satellite consisting of the Keplerian Elements.

- **Show Next Pass:** This will bring up the dialogue window showing the details about the next upcoming pass for this satellite.

- **Future Passes:** This will bring up the dialogue window showing the summary for the next N passes, N being a user configurable parameter (see section 5.1).

- **Highlight Footprint:** Selecting this option will highlight the area covered by the footprint of the satellite.

- **Ground Track:** Selecting this option will show the ground track of the satellite on the map. By default the ground track for the current orbit will be shown. If you select this option again, the ground track of the satellite will be deleted again. The map view can show the ground tracks for any number of satellites at the same time and for more than one orbit. The number of orbits can be configured in the preferences dialogue or the module settings editor.

---

4   Satellites that are very close to the bottom or either side of the map have their names printed above or on the side of the square, as is the case for TBD and TBD on figure TBD.
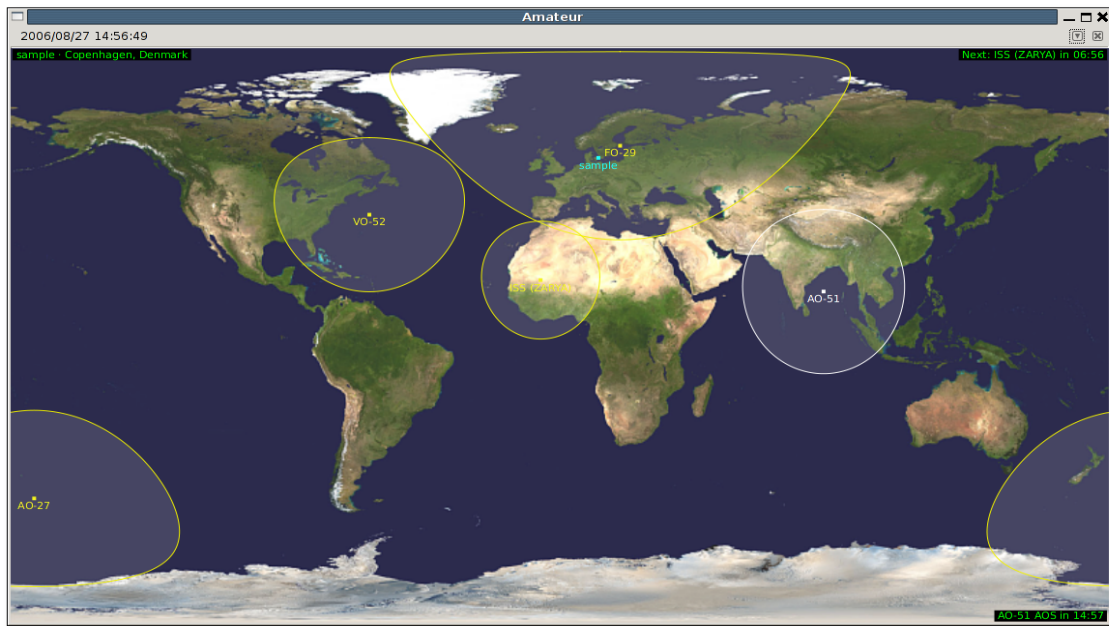
Figure 4.2: The map view using the default settings.

Gpredict offers you many configuration options to customise the look of the map view. The global default settings can be modified in the preferences dialogue, i.e. **Edit → Preferences → Modules → Map View**, and the settings for the map view in a specific module can be accessed via **Module Pop-Up → Configure → Properties → Map View**. A description of the configuration options is given below.

- **Background Map:** This setting determines which map file should be used as background map. The standard Gpredict distribution includes a few maps but you can also use your own maps. To select a new map, click on the **Select map** button. The map file has to be in a commonly used graphic format, for example Portable Network Graphics (PNG), and should have Greenwich in the middle, West to the left and East towards the right. Besides that there are no restrictions on the map size or the aspect ratio.

- **Extra Contents:** Using these setting you can determine which extra content should be displayed on the polar view:

- **QTH Info:** Checking this box will show the name of the ground station in the upper left corner of the polar view. The map view on figure TBD shows *sample*, since this is the name of the default ground station.

- **Next Event:** Checking this box will show in the upper right corner which satellite will come up next as when it will come up. The time is shown as a countdown to the event. Figure 4.2 shows that the next satellite will be ISS (ZARYA) and that it will come up in 06m56s. Please note that the countdown is not necessarily updated in real-time. Actually, it is only updated every time the map view is refreshed, see description of refresh rates in section 2.3.3 – Module Properties.

- **Cursor Position:** If this option is set, the latitude and longitude corresponding to the position of the mouse pointer will be displayed in real-time in the lower

left corner of the map.

- **Grid Lines:** Enabling this option will draw the grid lines on the map. The grid lines will be drawn for every 30°.

- **Colours:** These options allow you to change all colours used in the map view. You can pick a colour using a colour selector by clicking on the button showing the coloured rectangle. Note that the colours are specified using their red, green, and blue components and an additional alpha channel. The alpha channel determines the transparency of the colour. Colours which are very transparent may not be clearly visible on the colour picker button as is the case for the default Axes/Circles colour. Following colours can be set:

  o **Ground Station:** This colour is used to draw the small square and label at the position of the current ground station.

  o **Grid:** This colour is used to draw grid on the map.

  o **Tick Labels:** The colour used for the tick labels on the grid.

  o **Satellite:** The colour of the satellites, their labels, and footprint circles.

  o **Selected Sat.:** The colour of the selected satellite, its label, and its footprint circle.

  o **Ground Track:** The colour used to draw the ground track of a satellite.

  o **Coverage Area:** This colour is used to highlight the area covered by the footprint of the satellite. It is strongly suggested to make this colour *very* transparent.

  o **Info Text FG:** The foreground colour used for the additional information, e.g. Next Event.

  o **Info Text BG:** The background colour used for the additional information.

  o **Shadow:** Determines how strong the shadow below satellite markers and labels should be. This shadow is used to enhance the visibility of the satellites on the map when they are over light-coloured regions such as the South Pole or a desert area.

- **Display ground track for __ orbit(s):** This setting specifies for how many orbits the ground track of a satellite should be displayed. The default value is 1 and you can choose any value between 1 and 10.

4.2.3 The Polar View

The polar view (also called radar view) shows the satellites within range on a polar graph. The polar axis represents the azimuth of the satellites starting at North and turning towards East, while the radial axis represents to the elevation of the satellites with 90° at the centre, corresponding to looking straight up in the sky. Thus, the polar view is a projection of the sky as seen from the ground station with the centre of the graph corresponding to looking straight overhead. Figure 4.3 shows a screen capture of the polar view in Gpredict as it looks using the default settings.
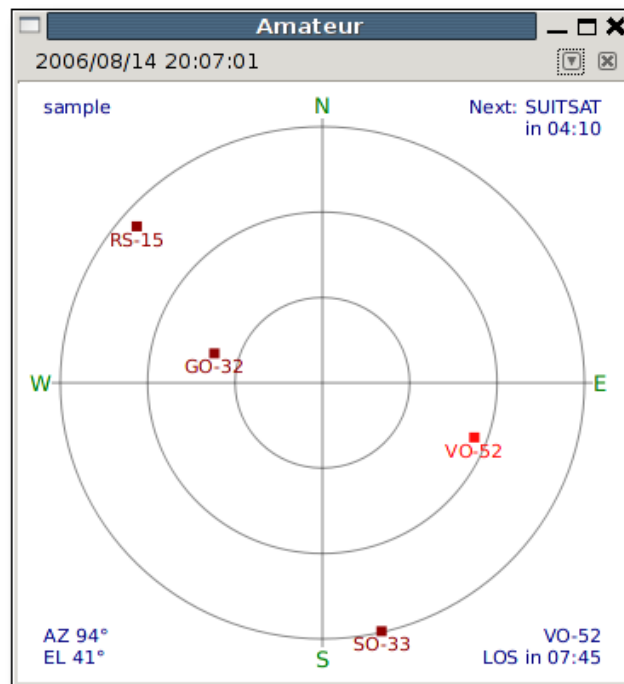
Figure 4.3: The polar view.

The satellites that are plotted on the polar view are selectable. If you left click on a satellite it becomes selected (changes colour) and the remaining in-range time for the selected satellite will be displayed in the lower right corner of the polar view. The selected satellite on figure 4.3 is VO-52 and it will get out of range (i.e. go below the horizon) in 7 minutes and 45 seconds.

You can only have one satellite selected at a time, thus clicking on an unselected satellite will clear any previous selection. Clicking on a selected satellite will deselect it.

You can also right-click on a satellite in order to bring up the satellite pop-up menu shown on figure 4.4. The satellite pop-up menu in the polar view gives you quick access to the following functions:

- **<SATELLITE NAME>:** Selecting this menu item brings up a small info window showing some static data about the satellite. Currently, this data consists of the orbital data (Keplerian Elements) as well as uplink, downlink and beacon frequencies for some satellites.

Figure 4.4: Polar View popup.

- **Show Next Pass:** This will bring up the dialogue window showing the details about the next upcoming pass for this satellite. When the satellite is above the horizon, a **Show Current Pass** option will also appear in the menu. This behaves the same as **Show Next Pass** except that it shows the current pass.

- **Future Passes:** This will bring up the dialogue window showing the summary for the next N passes, N being a user configurable parameter (see section 5.1).

- **Sky Track:** Checking this option will show the sky track of the satellite on the polar graph. If you select this option again, the sky track of the satellite will be hidden. The polar view can show the sky tracks for any number of satellites at the same time. When a satellite goes down, i.e. disappears from the polar view, its sky track will disappear, too.

- **Set Target:** Selecting this option will select the satellite as communication target. This function is currently disabled.

Gpredict offers you many configuration options to customise the look of the polar view. The global default settings can be modified in the preferences dialogue, i.e. **Edit → Preferences → Modules → Polar View**, and the settings for the polar view in a specific module can be accessed via **Module Pop-Up → Configure → Properties → Polar View**. A description of the configuration options is given below.
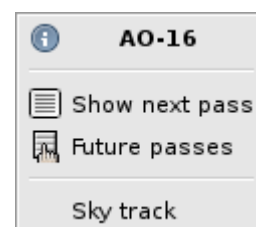
- **Orientation:** This setting determines the orientation and direction of the polar graph. The first letter defines the cardinal direction that should be placed at the top of the graph, then it continues clockwise with the second, third, and fourth letters:

  o **N/E/S/W** (default): North is at the top, South at the bottom, East on the right side, and West on the left side.

  o **N/W/S/E:** Same as the above but East and West swapped, hence we have West on the right side.

  o **S/E/N/W:** North and South swapped, as compared to the default setting.

  o **S/W/N/E:** Both North/South and East/West swapped as compared to the default setting.

- **Extra Contents:** Using these setting you can determine which extra content should be displayed on the polar view:

  o **QTH Info:** Checking this box will show the name of the ground station in the upper left corner of the polar view. The polar view on figure 4.3 shows *sample*, since this is the name of the default ground station.

  o **Next Event:** Checking this box will show in the upper right corner which satellite will come up next as when it will come up. The time is shown as a countdown to the event. Figure 4.3 shows that the next satellite will be SUITSAT and that it will come up in 4 minutes and 10 seconds. Please note that the countdown is not necessarily updated in real-time. Actually, it is only updated every time the polar view is refreshed, see description of refresh rates in section 2.3.3 - Module Properties.

  o **Cursor Position:** If this option is set, the polar coordinates of the mouse pointer will be displayed in real-time in the lower left corner of the graph.

  o **Extra Az Ticks:** Enabling this option will show some extra Azimuth ticks/axes on the polar graph at 30° intervals.

- **Colours:** These options allow you to change all colours used in the polar view. You can pick a colour using a colour selector by clicking on the button that show the coloured rectangle. Note that the colours are specified using their red, green, and blue components **and** an additional alpha channel. The alpha

channel determines the transparency of the colour. The higher the value the less transparent is the colour. Colours with an alpha value of 0 will be completely transparent, that is invisible! Colours which are very transparent may not be clearly visible on the colour picker button as is the case for the default Axes/Circles colour. Following colours can be set:

- o **Background:** The background colour.
- o **Axes/Circles:** This colour is used to draw the azimuth axes and the elevation circles.
- o **Tick Labels:** The colour used for the tick label, e.g. N, W, S, and E.
- o **Satellite:** The colour of the satellites and their labels.
- o **Selected Sat.:** The colour of the selected satellite and its label.
- o **Sky Track:** The colour used to draw the sky track of a satellite.
- o **Info Text:** The colour used for the additional information, e.g. Next Event.
- ● **Miscellaneous:**
  - o **Show the sky tracks automatically:** If you enable this check box the polar view will display the sky tracks for satellites as soon as they come in range. This means that you don't have to right click then select sky Track for each satellite. You can still hide the sky tracks manually.

There is no support to Save/Load colour schemes, nor is there any possibility to preview you changes. Should you end up with a bad colour scheme, you can always reset the settings to either the global defaults or the built-in factory settings. You can do that using the **Reset** button located at the bottom of the page.

4.2.4 The Single-Satellite View

The single-satellite view is a simple table showing details of one satellite at a time. Figure 4.5 shows a screen capture of the single-satellite view. Of course, you can pick any satellite that is associated to the parent module via the **Select Satellite** menu item in the single-satellite pop-up menu. You can access the pop-up menu by clicking on the small **V** icon located on the left side of the satellite name.

The single-satellite view is practically a miniature version of the list view; it can display the same data as the list view but for only one satellite at a time. Moreover, the single-satellite view displays the data vertically and is well suited to be placed in the small rectangular container areas of those layouts, which can contain three views.
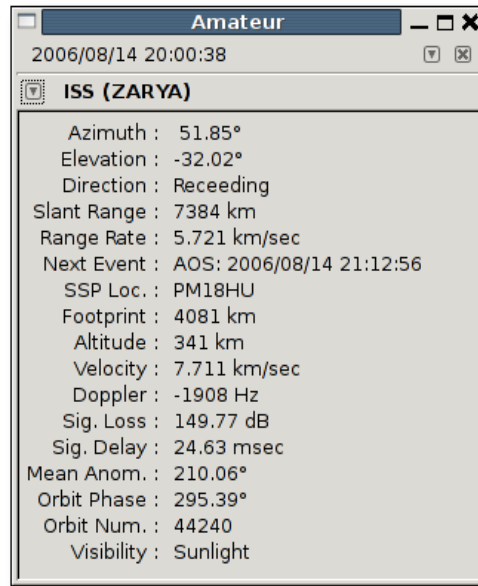
Figure 4.5: The single-satellite view.

4.2.5 The Upcoming Passes View

This view shows a simple list of the satellites in the module together with their Azimuth, Elevation and a count down clock until the next AOS/LOS. You can right click on the satellites to get info and predict future passes as in the other view.

This view has no configuration options.

Figure 4.6: The upcoming passes view.

5 Advanced Pass Predictions

5.1 Customising the Prediction Parameters

The parameters Gpredict uses for predicting satellite passes in the future can be customised to a great extent. To get access to these parameters go to **Edit → Preferences** and click on the **Predict** button. You will be presented with a notebook containing the prediction parameters organised in four notebook pages, see figure 5.1.

5.1.1 Pass Conditions

The parameters on this page define how Gpredict predicts future passes for satellites.
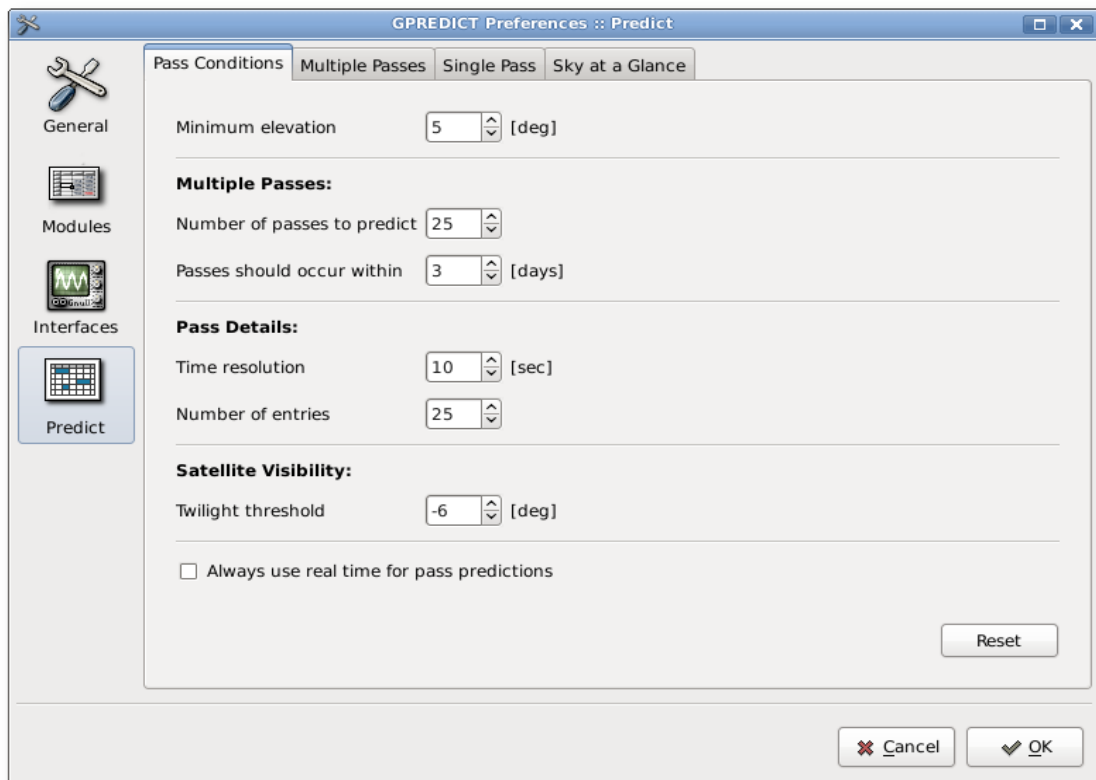
Figure 5.1: Parameters that control pass predictions.

Minimum elevation
This parameter define what Gpredict should consider as a satellite pass. If the elevation of the satellite stays below this threshold Gpredict will discard the pass and not will include it in the list of passes.

Number of passes to predict
This parameter defines how many passes Gpredict should try to find when looking for future passes.

Passes should occur within
This parameter sets the time limit within which the predicted passes should occur. When the time variable in the prediction algorithm reaches this time limit Gpredict will stop looking for passes even if it has not found the number of passes requested in the previous parameter.

These two parameter should therefore be thought of as "either or", i.e. Gpredict will either stop when it has found X number of passes or when it reaches the time limit – whichever comes first.

Time resolution
When showing the details of a given pass Gpredict will try to reach the time resolution specified with this parameter. This resolution should be thought of as a lower limit – the number of entries (next option) in the detailed pass prediction window will have precedence over this condition.

Number of entries
This parameter defines the number of entries Gpredict should display in the detailed pass prediction window. The exact number might deviate from this but it will always be around this number.

Twilight threshold
This parameter has influence on when Gpredict considers a satellite to be visible. Theoretically, a satellite can be visible if it is in sunlight but the ground station is in darkness. The problem is that darkness in this respect is not an absolute entity and this parameter defines the threshold for the elevation of the Sun at which the ground station is considered to be in darkness.

Following definitions exist for twilight:

Civil twilight	0° to -6°
Nautical twilight	-6° to -12°
Astronomical twilight	-12° to -18°

For most uses the "civil darkness" will be adequate.

Always use real time for pass predictions
If you check this option Gpredict will always use the current system time as starting point for future pass predictions, even when you are running in simulation mode. If you leave the box unchecked Gpredict will take the time from the time controller to predict future passes from.

5.1.2 Multiple Passes

The check-boxes on this page allows you to select what data Gpredict should show when listing multiple passes. You can choose between:

- Acquisition of signal (AOS) – the time when the satellite comes within range.
- Time of closest approach (TCA) – the time when the elevation of the satellite is at maximum during the pass.
- Loss of signal (LOS) – the time when the satellite goes out of range again.

- Duration of the pass.

- Maximum elevation during the pass.

- The satellite Azimuth when it comes within range.

- The satellite Azimuth at the time of closest approach.

- The azimuth when the satellite goes out of range.

- The orbit during which the pass will occur.

- The visibility of the satellite during the pass. Note that the visibility can change during the pass. This field will show a combination of three letters each of them indicating a visibility state (V=visible, D=daylight, E=eclipsed).
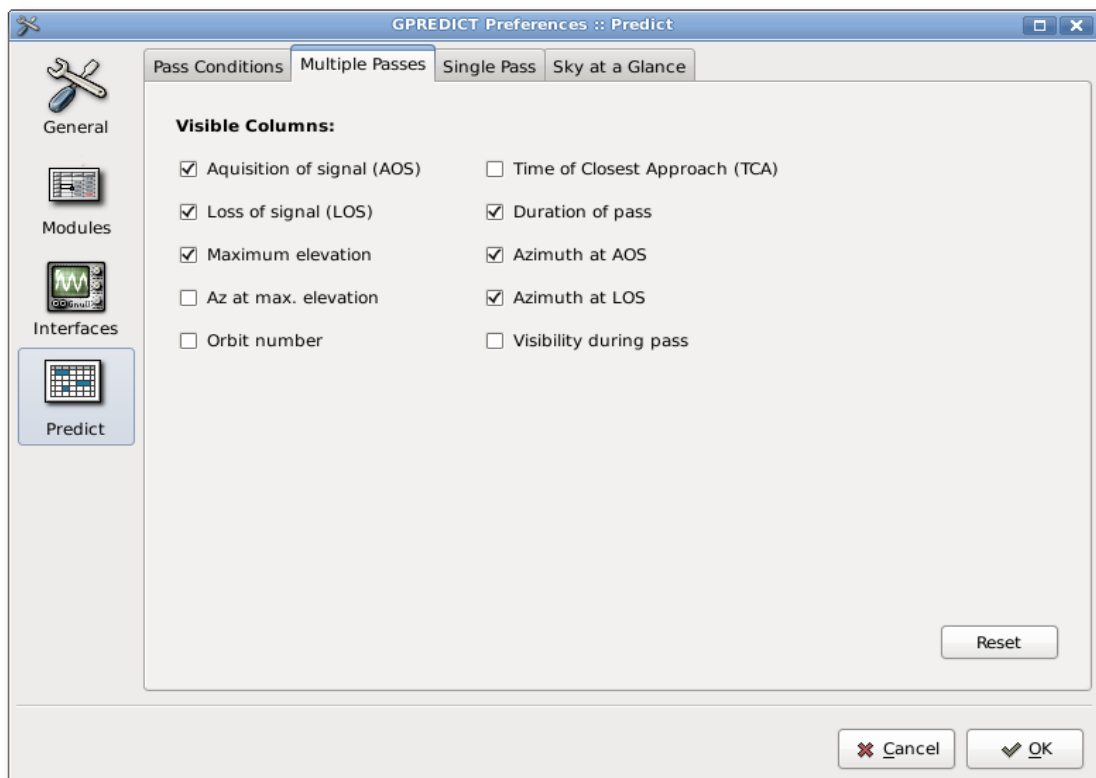
Figure 5.2: Configuration options for multiple pass predictions.

5.1.3 Single Pass
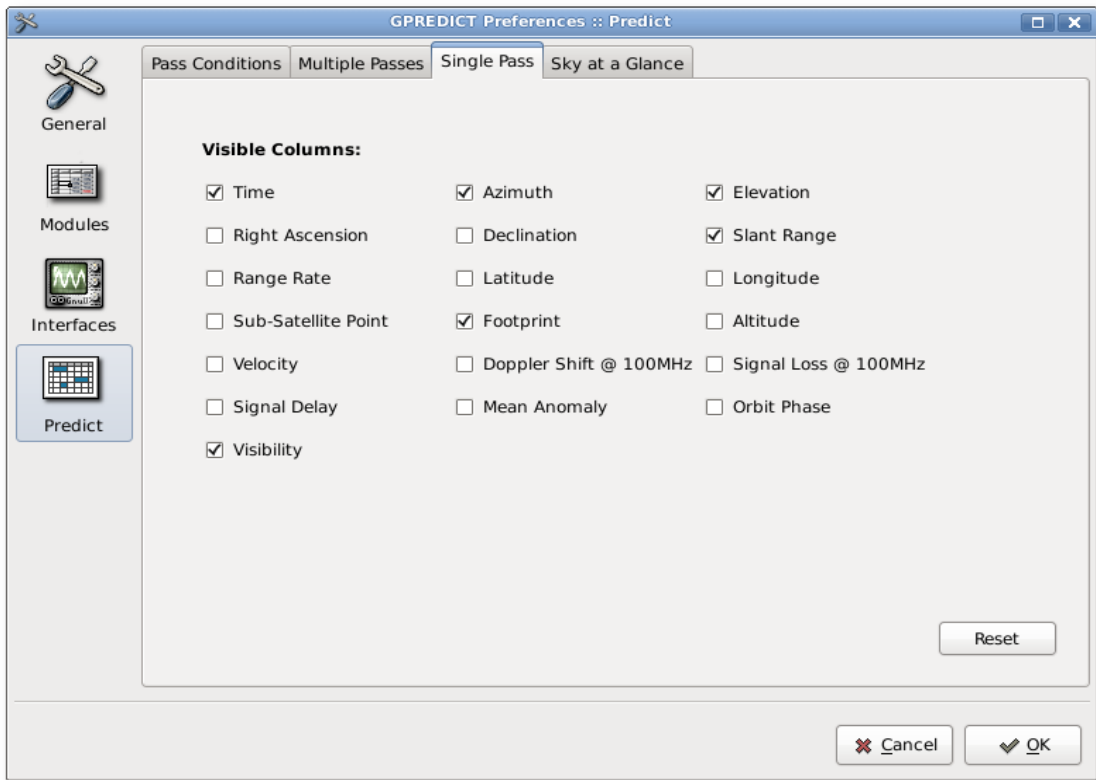
Figure 5.3: Configuration options for single pass predictions.

The check-boxes on this page allows you to select which data fields Gpredict should include when showing details about a pass. The choices are pretty much the same as for the list view and the single satellite view.

5.2 Sky at a Glance
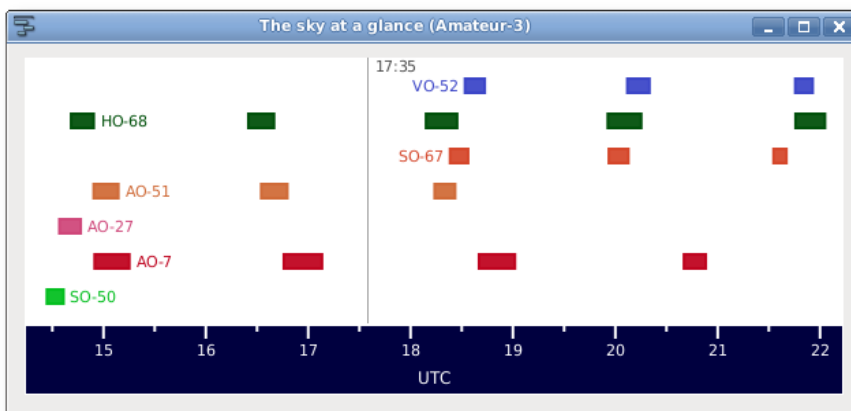
Figure 5.4: The sky at a glance.

The sky at a glance window gives you a quick overview of upcoming satellite passes for all satellites of a given module. The only parameter controlling the behaviour of this function is the length of the time axis, i.e. the time within which the passes should occur.

Besides that you can customise the colours used for each satellite. The sky at a glance window will show up to 10 satellites from the given module.

> If you leave the Sky at a glance window open it will update itself automatically once every minute. It will do so regardless of whether the time manager is running in real time, simulated real time or manual mode.

5.3 Communication Windows

This function is currently under development.

5.4 The Advanced Predictor

This function is currently under development.

6 Updating the Orbital Elements

6.1 Overview

Gpredict uses the NORAD SDP4/SDP4 algorithms to calculate the position of Earth orbiting satellites at any given time. These algorithms require knowledge about the orbit of the satellite as well as the position of the satellite on the orbit at some time T_0 a.k.a Epoch. These data are included with Gpredict in so-called TLE files.

Unfortunately, in the real world the dynamics of an Earth orbiting satellite can only be approximated (at least within reasonable time limit) and the SGP4/SDP4 algorithm is no exception to it. As the time difference to Epoch increases the calculation errors become more and more significant, in particular for satellites in low Earth orbit (few hundred km). Therefore, the TLE files containing orbital elements at Epoch must be updated regularly in order to stay up to date. Depending on the intended use of Gpredict, an update frequency between 1 and 4 weeks is reasonable.

Gpredict offers you three different ways to update the orbital elements at Epoch (T_0):

1. Automatic updates from the web via HTTP or FTP. This is the most convenient way to update the orbital elements since Gpredict will automatically download the latest data and update the local database.

2. Automatic updates from local files. This method can be used to update from files that have been acquired from sources that can not be accessed with Gpredict (e.g. email).

3. Manual update using the built-in orbital elements editor. This is definitely the least preferred way for updating orbital elements, nevertheless the method is useful for adding your own satellites to the Gpredict database, and experiment with satellite orbits.

Each of these methods are described in details in the following sections.

Gpredict stores the orbital elements in the NASA/NORAD two-line format[5], and the data you use to update the TLE files need to be in this format.

6.2 Automatic Update from the Internet

When your computer is connected to the internet, updating the TLE elements is as easy as selecting **Edit → Update TLE → Update from the internet** menu item in the menu bar. When you do that, Gpredict will by default fetch a subset of the TLE files available from http://celestrak.com, and update the internal database using the downloaded files. A small dialogue window showing the progress of the update process will pop up when you start the update. Please don't interrupt the process by

---

5 Actually, the NASA two-line format contains three lines for each satellite: One line for the satellite name and two data lines. There is also the NASA bare two-line format, which contains only two lines per satellite since it omits the line with the satellite name.

forcing this dialogue to close. Sometimes, when the network connection to the remote server is slow or otherwise bad, it may take some time until Gpredict decides to give up and cancel the update process. There is a built-in connection time-out of 10 seconds per data file. If Gpredict fails to retrieve fresh TLE data the process will go through but at the end you will see that the number of satellites updated is 0.

As mentioned earlier in this chapter, it is rather important to have the TLE data updated at regular intervals. Gpredict can help you remembering when it is time to update the TLE data by reminding you once per week that it is now time to a TLE update. This default behaviour can be changed in the preferences dialogue, see **Edit → Preferences → General → TLE Update**. Figure 6.1 shows how this configuration page looks like.
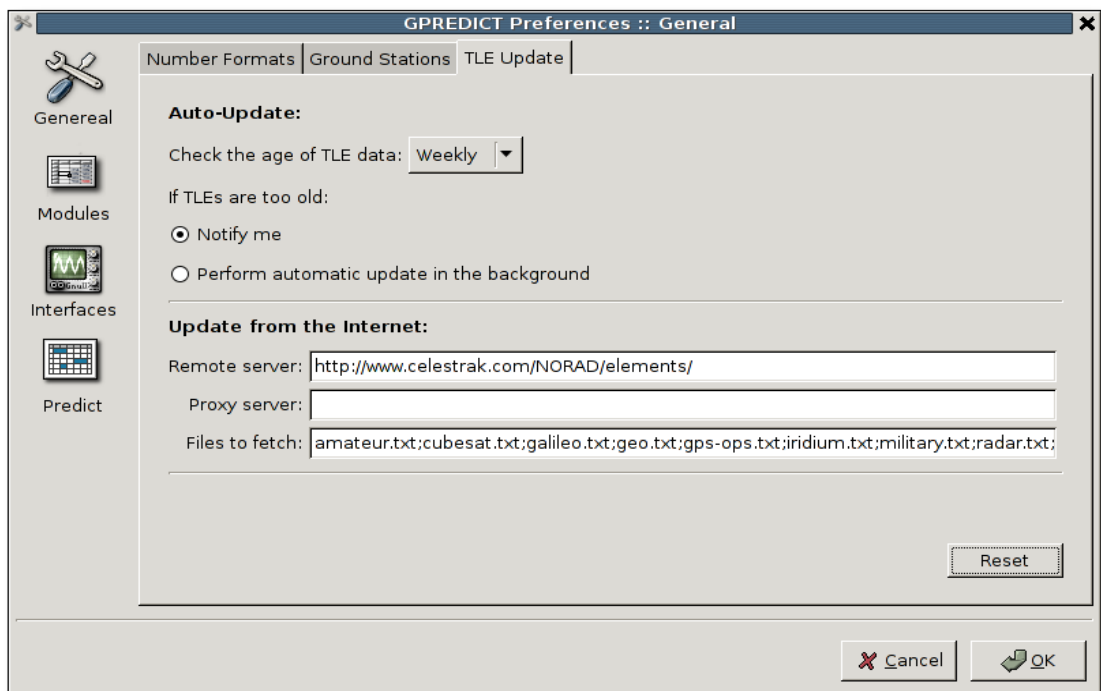
Figure 6.1: Configuration options for TLE updates.

6.2.1 Auto-Update

These settings define how Gpredict should check the age of TLE data and what it should do when it finds that the TLE data is getting out of date.

First, you can determine how often Gpredict should check the age of the TLE data. Possible choices are: Daily, Weekly, Monthly, and Never. The default value is weekly, and it seems to be a good update frequency for most users.

Second, you can define what Gpredict should do when it decides that it is time to update the TLE data. The default and most obvious action is to send a notification to the user. This is done by popping up a dialogue box with the reminder, where after the user can initiate an update as described earlier in this section. The other possibility is to let Gpredict perform a fully automatic update in the background without any notification to the user – not even in case of error. If you choose to use this option, you should keep an eye once in a while on whether the updates are actually performed or not. You can do that either by checking the satellite info dialogue or by examining the log messages produced by Gpredict.

Please note that both the notification mechanism and the autonomous, silent update are relatively new functions in Gpredict. Consequently they are far from perfect and are most likely to undergo improvements in future versions of Gpredict. Your comments and suggestions will be highly appreciated.

6.2.2 Update from the Internet

In order to perform automatic or semi-automatic TLE-updates from the internet, Gpredict needs to know what files to fetch and from where. By default, Gpredict is configured to download all of the "interesting" data from CelesTrak, but you may want to perform the updates from somewhere else or using other files. There are three parameters that are relevant here:

1. **Remote server:** This specifies the complete remote URL consisting of the network protocol (HTTP, FTP, etc.), the server name, as well as the directory on the server where the files are located.

2. **Proxy server:** If you are behind a proxy server, you can enter the name or address of the server here.

3. **Files to fetch:** A list of files that should be downloaded from the remote server. The files should be separated by a **;** (semicolon).

Currently, Gpredict only supports updates from TLE files that are in the NASA two-line format (plus a third line for the satellite name), and you should ensure that the data is in the correct format, wherever you do your updates from. Wrong format will not crash Gpredict but it will not update anything either.

There is one potentially dangerous shortcoming in the current implementation of TLE updates from the internet, namely authentication. If either the remote server or your proxy server requires authentication, the only way to specify the user name and password is to include them into the URLs:

protocol://user:password@example.com/path/

Be warned that the URL string and thereby your user name and password will be stored as clear text in the Gpredict configuration file, which may be readable by anybody who has access to your computer. To help this you can change the permissions of the `gpredict.cfg` file so that only you have read and write permissions on it. At the same time, please create an issue submission at https://github.com/csete/gpredict/issues asking us to implement better handling of passwords in Gpredict – if enough people complain about this we will eventually have to do something about it.

6.3 Semi-Automatic Update from Local Files

If you can not update the TLE files using the internet, you still have the option to perform a semi-automatic update using local files. In order to update the TLE data from local files, you can do the following:

1. Acquire the fresh TLE files and store them in a directory. The files must be in the NASA two-line format.

2. Select the **Edit → Update TLE → Update from local files** menu entry in the menu bar.

Gpredict will then ask you to specify a directory where the fresh TLE files are located, see figure 6.2. Click the button, select **Other...** in the list of entries, and find the directory where the fresh TLE files are located. Click OK and you'll see the same progress dialogue as in the case of updating from the internet.

If you plan to update the TLE from local files often, it is recommended to use a dedicated directory for that purpose. Gpredict will indeed remember the last chosen directory till the next time you use this function. Moreover, if you for some reason are going to use multiple TLE source directories, you may consider storing these directories as bookmarks in the file selector dialogue.
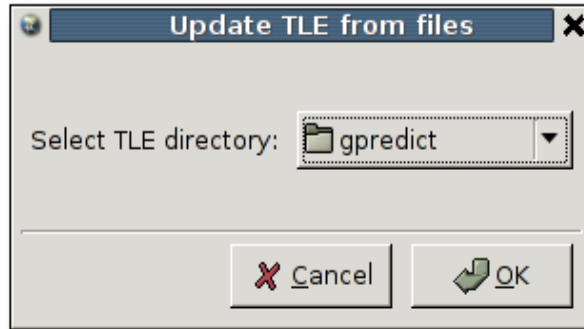

Figure 6.2: Selecting a directory to update the TLE data from.

6.4 Manual Update

This function has not been implemented yet and is currently disabled.

7 Controlling Radios and Rotators

7.1 Overview

Beginning with version 1.0 Gpredict can do Doppler tuning of radios and tracking of antenna rotators via Hamlib, see http://hamlib.sourceforge.net. This is done via hamlib's rigctld and rotctld TCP/IP interface and requires that hamlib version 1.2.8 or later is installed on the computer to which your radio and/or rotator device is connected.

Since this interface uses an internet protocol, you can either have Gpredict control devices connected to the same computer or you can control devices connected to a remote computer.

Gpredict is very flexible when it comes to controlling radios. You can use both receivers, transmitters, and transceivers. You can even use two separate radios for uplink and downlink.

The rest of this chapter will guide you through setting up Gpredict and hamlib to perform radio and rotator control. You should read this chapter carefully if you plan to use Gpredict for these tasks. If you have difficulties understanding this section or you miss some information, feel free to seek support on the Gpredict forum at http://forum.oz9aec.net.

Before you set up Gpredict to control your hardware devices it is very important to ensure that the hamlib interface works properly with your devices. Many low-level drivers in hamlib have been written from specs and might not have been tested with real hardware at all. You could be the first person to actually test a particular driver with real hardware!

Connecting Gpredict to a hardware device without knowing that the hamlib driver works properly may cause serious damage to your hardware and for the surrounding environment.

Regardless of whether your setup works or not, please provide feedback to the developers via the Gpredict Froum at http://forum.oz9aec.net

7.2 Hamlib Tutorial

This section gives you an introduction to hamlib and in particular to the command line utilities that come with it. It is very important that you know how to use these tools – otherwise you will not be able to configure Gpredict properly. If you are already familiar with the hamlib command line utitlities you can skip this section.

Hamlib is a set of libraries that provide low-level radio and antenna rotator drivers for applications such as Gpredict. Besides the libraries hamlib includes a few command line utilities that allow testing of the drivers. These are:

- **rigctl** – allows you to send commands to your radio from the command line

- **rotctl** – allows you send commands to your antenna rotator from the command line

- **rigctld** – allows you to send commands to your radio via a network interface using TCP/IP protocol

- **rotctld** – allows you to send commands to your antenna rotator via a network interface using TCP/IP protocol

For testing the hamlib driver with your radio and/or rotator you will use rigctl and rotctl. For setting up Gpredict to control your devices you will use rigctld and rotctld. All of these command line utilities have their own manual pages that can be accessed by typing *man rigctl* in a terminal. While this tutorial gives you a brief introduction to hamilb so that you know just enough to configure Gpredict, I strongly encourage you to study these manual pages for a complete reference about these tools.

Before you can use the hamlib tools you will need to gather some info about your devices. These are

Model number	This is the Hamlib ID of your particular radio or rotator. The complete list of supported radios and rotators and their hamlib ID can be obtained by executing: ``` rigctl --list ``` or ``` rotctl --list ``` If you are human and cannot read the whole list while it scrolls by, try using `grep` or `less.` For example, to find the ID of the YAESU FT-847 try: ``` rigctl --list	grep FT-847 101 Yaesu FT-847 0.2 Alpha ``` This tells you that the FT-847 has model ID 101, the driver has version number 0.2 and is considered to be in Alpha state (meaning that it hasn't been tested using a real radio).
Device	This is the Unix file name of the device where your radio/rotator is connected to. Serial devices are usually called /dev/ttyS0, /dev/ttyS1

	and so on. USB devices including USB to serial adaptors appear as /dev/ttyUSB0, /dev/ttyUSB1, etc.
Serial Speed	This is usually set in your radio and although hamlib provides some default values, it is safest to specify it when you load the driver
CIV Address	For ICOM radios you will need to know the CIV-address if it has been changed from the default CIV address. If your ICOM radio uses the factory default settings you do not need to tell hamlib what CIV to use.
DTR and CTS settings	Some special interfaces, e.g. Microham USB I/F, use the DTR and CTS lines for specific purposes such as PTT and CW keying. Hamlib sets these lines ON by default and you might need to disable it explicitly.

Hamlib provides a driver for a fictive radio and rotator called **dummy**. This driver has model number 1 and you can use this driver while you learn to use the command line utilities. It is also recommended to use this driver while you get used to the controller user interface in Gpredict.

7.2.1 Rigctl

Rigctl is an interactive command line tool for sending command to and reading status from your radio. When you invoke rigctl you need to tell it which radio you want to control and how to connect to it. For example, the command line:

```
rigctl --model=344 --rig-file=/dev/ttyUSB0
```

will connect to you ICOM IC-910 connected to the first USB port using the default settings for serial speed, CIV address, etc.

The command line arguments also have a short version consisting of a single letter. Using the short version the above command would be:

```
rigctl -m 334 -r /dev/ttyUSB0
```

You can mix the short and long versions as you whish.

By default, hamlib sets the DTR and RTS lines of the RS232 interface high. If you have an adaptor that uses these lines for special purposes such as CW and PTT you will need to disable the lines using the `--set-conf` option:

```
rigctl –model=334 ...  --set-conf=dtr_state=OFF,rts_state=OFF
```

There are many other configuration options that can be modified using the `--set-conf` command line argument. To get a complete list of the configuration options

simply type `rigctl -L`.

Another very useful option is the `-v` parameter, which specifies verbosity level of the debug messages that are printed by rigctl. The more v's you include the higher the verbosity of the output messages. The highest number is 5 corresponding to `-vvvvv` which will print as much as possible – in most cases even the RS232 traffic. This is very useful for debugging bogus drivers.

Table 7.1 below lists some of the most common command line options for rigctl. For a complete reference you should consult the rigctl manual page, i.e. `man rigctl`.

Command		Description
-m ID	--model=ID	Specify the model ID of your radio. See `rigctl --list` for a complete list of supported radios.
-r dev	--rig-file=dev	The file name of the device where your radio is connected. Serial ports usually have file names /dev/ttyS0, /dev/ttyS1, etc. while USB adapter including USB-to-RS232 converters usually have device names /dev/ttyUSB0, /dev/ttyUSB1 and so on.
-s baud	--serial-speed=baud	Use baud for serial speed. By default hamlib uses the highest rate the specified radio is known to support; however, often this setting will be specific to what the radio has been configured to and should therefore always be specified.
-c CIV	--civaddr=CIV	Sets the CI-V address for ICOM radios. If not specified hamlib will use the factory default CI-V address of the specific model. You only need to use this option if the CI-V address of your ICOM radio is different from the factory default. You can specify the address using both decimal notation and HEX, in the latter case the address must be prefixed with 0x

Command		Description
-L	--show-conf	List all the configuration parameters that are available for the radio.
-C	--set-conf=par=val	Set configuration parameters. Use -L to get a list of configuration parameters). Normally you will use this if you need to set DTR and RTS OFF and to configure parameters of the serial communication (e.g. data bits, stop bits, handshake, and so on).
-l	--list	Lists all supported radio with their model number.
-v		Set the verbosity level of output messages. The highest level is 5 corresponding to -vvvvv and in this mode hamlib will output all information available.

Table 7.1: Most common rigctl command line options.

Once you are in rigctl it will prompt you for a command to enter. To get a list of available commands type a question mark. In order to check the driver for using it with Gpredict you should at least check that the set/get frequency and get_ptt commands work properly. You can do this with `F` (set freq), `f` (get freq), and `t` (get ptt)

commands.

7.2.2 Rotctl

Rotctl is very similar to rigctl in terms of command line options, the only significant difference being that you can not specify the CI-V address.

Once you have the rotctl command prompt you can set and get the position of your rotator using **P** and **p**. As with rigctl, you can get the full list of available commands by typing **?** At the rotctl command prompt.

7.2.3 Rigctld and Rotcld

Rigctld and rotctld are similar to rigctl and rotctl except that they act as a TCP/IP server and do not present you with a command prompt. They take the same command line arguments for specifying the connection to the hardware. In addition to that, rigctld and rotctld take an optional parameter **-t 1234** or **--port=1234** to allow the user to specify which TCP port the server should use.

The default port is 4532 for rigctld and 4533 for rotctld and you don't need to change that unless those ports are already in use (e.g. by another rigctld or rotctld server).

In order to start a radio or antenna rotator server you simply start rigtctld or rotctld with the same command line arguments as you used for rigctl and rotctl.

7.3 Configuring your Devices in Gpredict

Now that you have tested hamlib with your radio and antenna rotator we are ready to move on and configure Gpredict.

To enter the radio and antenna rotator settings in Gpredict select **Edit →
Preferences** in the menu bar and click on the **Interfaces** button in the left part of the dialogue. You should see something that looks like the dialogue shown on Figure 7.1 below.

The main view of the dialogue will show the list of already configured radios, which is initially empty. At the bottom you will find three buttons for adding, editing, and deleting your radio configurations.
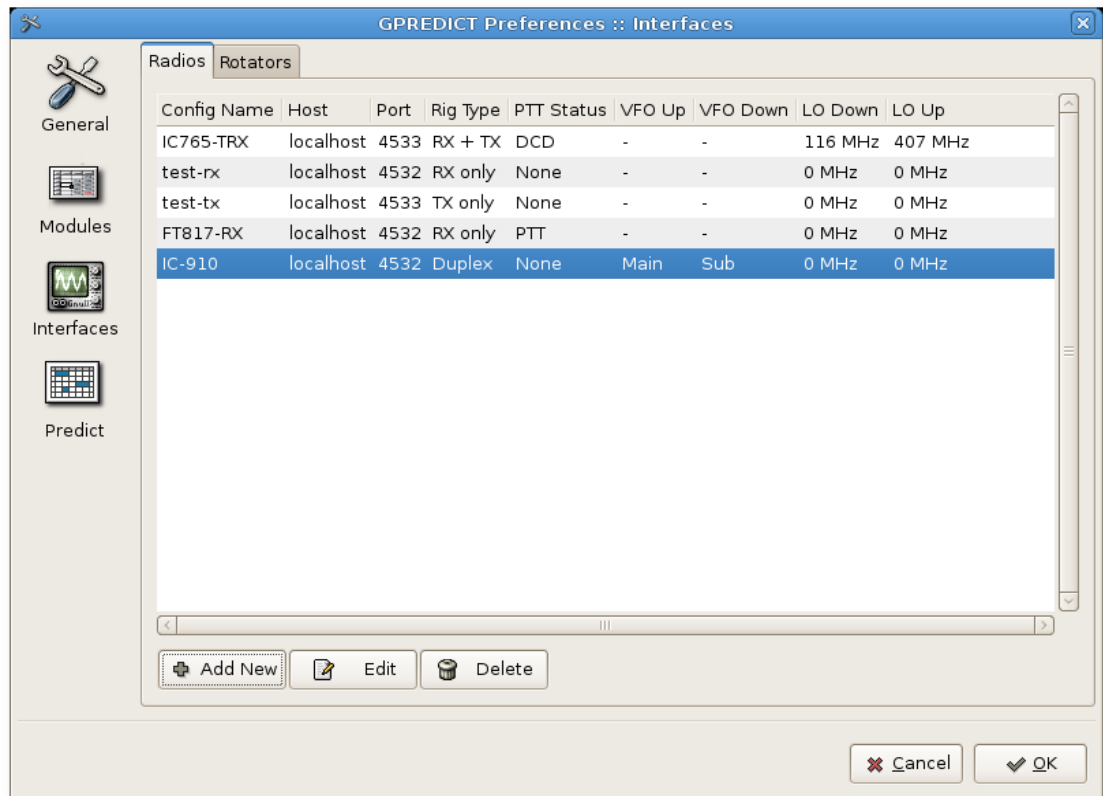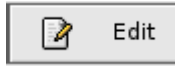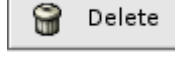
Figure 7.1: Radio and rotator settings.

	Click this button to add a new radio configuration. You will get a small dialogue window as shown and explained in the following section (section 7.3.1).
	Click this button to edit an existing configuration. This brings up the same dialogue as when you add a new configuration, but now the fields are filled with the values for the selected configuration.
	Click this button to delete an existing configuration. The configuration will be completely removed.

Note that any changes you make will not take effect until you press the **OK** button. In case you **Cancel** the Preferences dialogue, any changes you may have made to your radio and rotator settings will be reverted to the state before you opened the Preference dialogue.

You can configure as many radio and rotator devices as you have or want; you will always be able to choose one specific device to use in a given situation during runtime.

7.3.1 Radio Configuration

Configuring a radio device is very simple, see Figure 7.4. The four fields that are required are explained below.
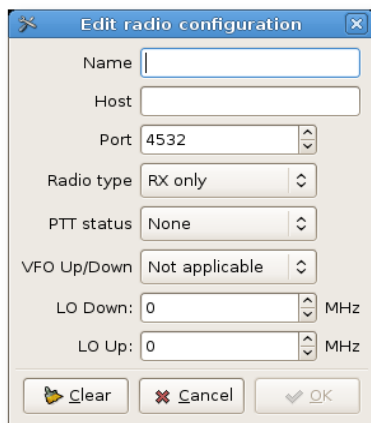

Figure 7.2: Radio setup.

Name:
A unique name for the configuration. You can use alphanumeric characters as well as underscore and minus.

Host:
The host name or IP address of the computer to which your radio is connected to. If this is the same computer on which Gpredict is running you can enter localhost.

Port:
The port number where rigctld is listening. By default rigctld uses port 4532.

Radio type:

The type of this radio.

- RX only: The radio should only be used as receiver. This is useful if you have a radio where the TX frequency can not be adjusted via the CAT interface (e.g. Yaesu FT-817).

- TX only: The radio should only be used as transmitter. This option is only useful if you have a radio that is dedicated for uplink.

- Simplex TRX: The radio should be used for both reception and transmission but only one at a time. This option is useful for transceivers that can work in split mode and where the frequency can be adjusted via CAT regardless of whether you are in RX or TX mode. For this option to work it is a prerequisite that Gpredict can read the PTT status via CAT.

- Duplex TRX: The radio is a full duplex radio, such as IC-910H, FT-847 or TS-

2000.

- FT817/857/897 (auto): This is a special mode specific for the YAESU FT-817, 857 and 897 radios. These radios do not allow the frequency to be set via CAT while they are in TX mode. When using this mode, the transmitter frequency will be adjusted while the radio is in RX mode by toggling the VFO. This way the transmitter frequency will stay close to the ideal, Doppler corrected frequency.

- FT817/857/897 (manual): This is similar to the previous mode except that automatic update of the TX frequency is not performed. Instead, the user can use the SPACEBAR key for PTT. When the SPACEBAR key is pressed, the controller will update the TX frequency and then enable PTT. Pressing the SPACEBAR again will disable PTT.

PTT Status:

If you select any other option than None, Gpredict will read the status of the PTT and act accordingly, meaning that RX tuning will only be done if PTT is OFF and TX tuning will only be done while PTT is ON. It is a very important option if you want to use the same radio for both RX and TX regardless of whether the radio type is RX only, TX only, or Simplex TRX.

If your radio support reading the PTT status via CAT select the **Read PTT** option. For FT817/857/897 you should select this option.

If you have a radio that could be used as Simplex TRX but it does not support reading PTT status via CAT, you might be able to use the **Read DCD** option. This requires that your radio outputs some signal that indicates the PTT status (most transceivers do that) and that you use a special CAT interface that can route this signal to either CTS or DSR and configure rigctld to use these signals for DCD:

```
rigctl –model=334 ...  -d /dev/ttyUSB0 --dcd-type=CTS
```

The PTT Status option has no effect for full duplex radios.

VFO Up/Down

If you are using Gpredict to control a full-duplex capable radio, such as the IC-910H or FT-847, you need to tell Gpredict which VFO to use for up and downlink. This setting is different from radio to radio and you should consult the operation manual of your radio for the correct setting. Also note that you will have to set your radio into full-duplex mode before letting Gpredict control it.

This setting is only used for full-duplex radios and has no effect if the radio is receiver, transmitter or simplex transceiver.

LO Down and Up:

These options allow you specify an offset/local oscillator frequency if you use a transverter with your radio. For example, if you are using a downlink transverter with your HF receiver in the 28-30 MHz range to track satellites in the 144-146 MHz

range, your LO Down frequency would be 144 – 28 = 116 MHz. Similarly for LO Up, which is for uplink.

7.3.2 Antenna Rotator Configuration

The antenna rotator setup is similar to the radio setup except a few parameters that are described below.

Az-type:
By default, Gpredict assumes that the azimuth axis of the rotator goes from 0° to 360° with 0° pointing towards North and the center 180° pointing towards South. There are, however, azimuth rotators that are centered around 0°, which is North, and go ±180°, i.e. their azimuth range is –180° to +180°. Select –180° → 0° → +180° if you have one of these rotators and Gpredict will automatically take this into account when tracking satellites with your rotator.

Figure 7.3: Rotator setup.

Min/Max Az/El:

When you select Az-type Gpredict will automatically provide the proper ranges. However, if your rotator has a wider or narrower range for either Az or El you can specify it here.
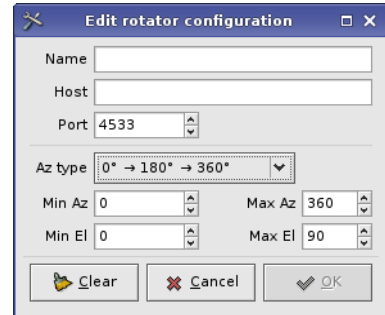
7.4 Controlling your Devices with Gpredict

The radio and rotator control interfaces are attached to a specific module. You can control one radio and one antenna rotator per module at any given time. If you have more than one module open, you can have one radio and one rotator interface open for each module. Thus, if your task is to monitor two different transponders of the same satellite using two different radios, you simply need two modules having the same satellite.

You can access the radio and antenna rotator control windows via the module popup menu, see Figure 2.3.

7.4.1 The Radio Control Window

The radio control window shown on Figure 7.4 consists of four areas: Satellite, Radio, Target, and Device. Each of these are described below.
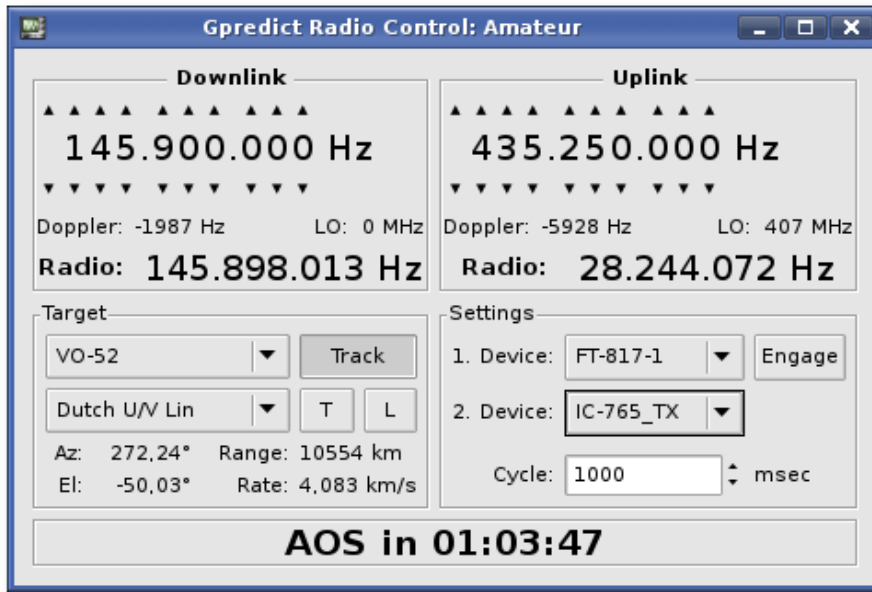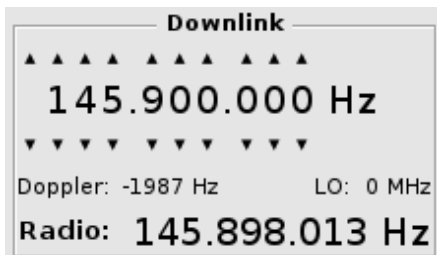
Figure 7.4: The radio control interface.

The **Downlink** area contains the control and status widgets for the satellite downlink frequency. Besides the downlink frequency it also shows the Doppler shift at the current downlink frequency, the transverter offset if any, and the corrected frequency that should be on your radio, i.e. SAT+Doppler-LO.

Note that Doppler correction is only applied if **Track** is enabled (see below). Similarly, LO correction is applied if the selected device is **Engage**'d (see below).

To change the frequency you can click on the arrows or directly on a digit. When clicking on a digit you can use both left and right buttons as well as the scroll wheel.
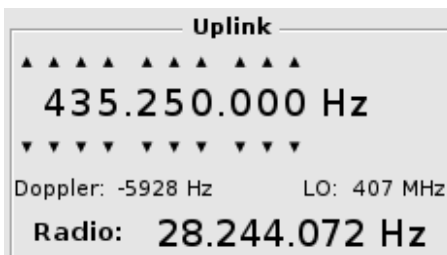
The **Uplink** area shows the control and status widgets for the satellite uplink. It has the same properties as the **Downlink** area.

Note that the status widgets are updated even if you are using a receive-only radio. This is particularly useful if you are using radios where the frequency can not be set via CAT while they are in TX mode. This is the case for the FT-817; if you intend to use an FT-817, you should configure it as RX only. Gpredict will then only correct the downlink, but will

	still display the corrected uplink so that you can apply the correction manually while you are transmitting.
	The **Target** area contains widgets for selecting the target object as well as the transponder for the selected target object. You can select a new target at any time and any effects it might have on the radio settings will be applied instantaneously. Note, however, that the Doppler shift is only applied to the operating frequency if you enable the **Track** button.
	Pressing the Tune button **T** will cause Gpredict to tune to the middle of the passband for the selected transponder.
	Pressing the Lock Button **L** will lock the uplink and downlink so that any changes to one of them will update the other – provided that the selected transponder is a transponder with a passband, i.e. it doesn't work for beacons and single channel transponders.
	The **Settings** area contains widgets for selecting the radio devices from the ones you have configured (see section 7.3.1). The **Engage** button is used to toggle the connection between the controller and the hamlib driver(s). Commands are sent to the radio device only if the device is engaged.
	You can use up to two devices in any controller. The **1. Device** is the primary device and will be used as downlink and uplink depending on the device type (and the selection in the 2. Device). The **2. Device** is the secondary device and is used for uplink only and therefore it only lists radios that are not of type RX only.
	The code that communicates with hamlib runs in its own thread and is activated periodically. the **Cycle** parameter defines the delay between two such cycles. A value of 1 second should be adequate for most uses.
	Note that when the controller algorithm detects 5 subsequent errors in the communication with hamlib the device will be automatically disengaged.
	In the bottom of the window you will find a counter counting the time left until next AOS or LOS event. The format is HH:MM:SS.

Assuming that you have tested and configured your radios properly, all you need to do to start tracking a satellite with your radio is:

1. Select the satellite in the Target box.

2. Select the transponder you want to track.

3. Enable the Track button. You should now see the Radio frequency being corrected for Doppler shift with respect to the Satellite frequency.

4. Select the proper radio device(s) in the Settings area.

5. Enable the Engage button.

You can at any time disable the Doppler correction by disabling the Track button – regardless of whether the radio device is engaged or not. Similarly, engaging and disengaging the device can be done at any time. Note that if Gpredict detects too many communication errors with hamlib it will automatically disengage the device(s).

Note that when tracking is enabled Doppler correction will be applied regardless of whether the satellite is within range or not.

An overview of the operating modes of the radio controller algorithm is given in Table 7.3 below.

Track	Engage	Description
OFF	OFF	No Doppler correction is performed. No commands are sent to the radio(s). The current frequency of the radio(s) is not read.
ON	OFF	Doppler correction is applied, but no commands are sent to the radio(s) and the current frequency of the radio(s) is not read back either.
ON	ON	Doppler correction is applied and the frequency setting commands are sent to the radio(s). The current frequency of the radio(s) is read back and is taken into account by the active feedback algorithm.
OFF	ON	Doppler correction is not performed but frequency commands are sent to the radio(s) and the current frequency is read back from the radio(s). This mode can be used for manually controlling a remote radio.

Table 7.2: Operating modes of the radio controller.

Further instructions on how to configure specific radios to be used with Gpredict may be found in the Gpredict forum: https://community.libre.space/c/gpredict

7.4.2 The Rotator Control Window

The rotator control window shown on Figure 7.5 consists five areas: Azimuth, Elevation, Target, Settings, and a Polar Plot. Each of these areas are described below.
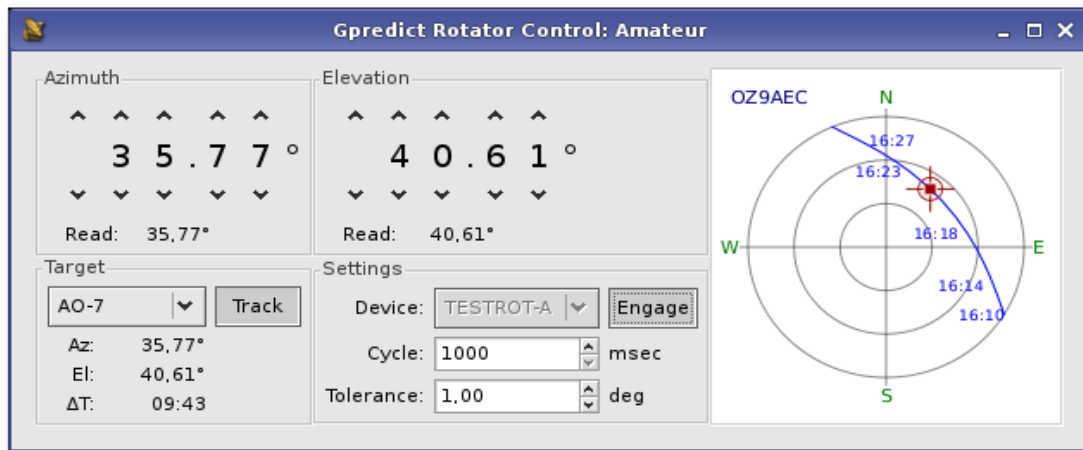
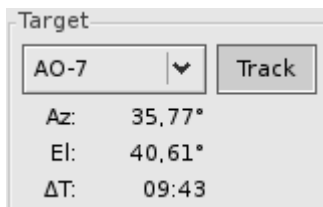Figure 7.5: The rotator control interface.

|	
	The **Azimuth** area allows you to control the Azimuth of the rotator device. You can change the value by clicking on the corresponding arrows or digits; however, if tracking is enabled your changes will be overridden with the Azimuth of the target satellite. The bottom of the area contains a field showing the current Azimuth as read back from the rotator device. If the device is not engaged this field will simply show **---** instead of a number. If there was error in the communication with hamlib this field will show **ERROR**.
	The **Elevation** area allows you to control the Elevation of the rotator device. You can change the value by clicking on the corresponding arrows or digits; however, if tracking is enabled your changes will be overridden with the Elevation of the target satellite. The bottom of the area contains a field showing the current Elevation as read back from the rotator device. If the device is not engaged this field will simply show **---** instead of a number. If there was error in the communication with hamlib this field will show **ERROR**.
	The **Target** area contains widgets for selecting the target object. You can select a new target at any time and any effects it might have on the rotator settings will be applied instantaneously. Note, however, that the target position is only applied if you enable the **Track** button. The ΔT field shows the time left until AOS or LOS in HH:MM:SS format.
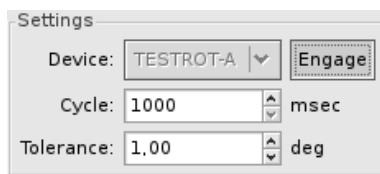
The **Settings** area allows you to select one of your rotator devices that you have configured (see section 7.3.2).

The Engage button is used to toggle the connection between the controller and the hamlib driver. Commands are sent to the rotator device only if the device is engaged.

The code that communicates with hamlib runs in its own thread and is activated periodically. the **Cycle** parameter defines the delay between two such cycles. A value between 2-5 seconds should be adequate for most uses.

The **Tolerance** parameter can be used to specify the difference between set and get positions that you can tolerate. When the difference between the set and get values exceeds this parameter a command is sent to the rotator. The value of this parameter should be set according to your hardware characteristics, i.e. no need to set the tolerance to 0.1° if your rotator precision is ±1° and your antenna beam width is 25°.

Note that when the controller algorithm detects 5 subsequent errors in the communication with hamlib the device will be automatically disengaged.
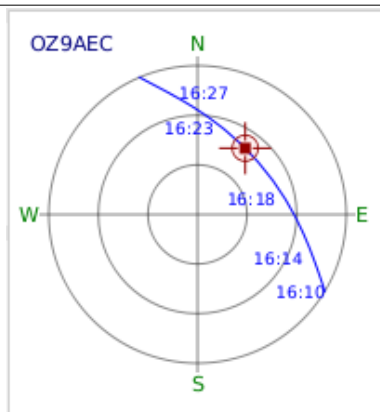
The **Polar Plot** area on the right side of the window is provided to guide you while you are tracking a satellite. It shows the next pass of the currently selected target satellite.

The small rectangle represents the currently selected target satellite if it is within range. The circle around the rectangle represents the current position of the controller while the cross represents the current position of the rotator device (if engaged).

If the rectangle, the circle, and the cross are all aligned you are successfully tracking the target satellite :-)

When you open the rotator control window tracking will be disabled and the rotator device disengaged. Select the appropriate device and engage. You can now control the rotator manually using the Azimuth and Elevation control widgets. You should be able to see the red circle and the cross move around the polar plot according to your settings and the current position of the rotator.

When you want to start tracking a target satellite you simply enable the **Track** button.

Note that when tracking is enabled any manual position changes will be overridden by the position of the currently selected target. Note, however, that active tracking will be carried out only if the target satellite is within range. If tracking is enabled while the target satellite is out of range, the rotator controller widgets will be set to the position where the target satellite is expected to appear at the next AOS.

The **Cycle** and **Tolerance** parameters can be changed at any time regardless of

whether the rotator device is engaged or not. Similarly, you can at any time select a new target even when your rotator device is engaged.

An overview of the operating modes of the antenna rotator controller algorithm is given in Table 7.3 below.

Track	Engage	Description
OFF	OFF	Controller widgets are not updated with respect to target position. No commands are sent to the rotator and the current rotator position is not read back either.
ON	OFF	Controller widgets are updated with target position but no commands are sent to the rotator. Current rotator position is not read back either. If the target satellite is out of range the controller widgets will be set to the position where the satellite is expected to appear at the next AOS.
ON	ON	Controller widgets are updated with target position and the position is sent to the rotator. The current position is read back from the rotator device. If the target satellite is out of range the controller widgets will be set to the position where the satellite is expected to appear at the next AOS.
OFF	ON	Controller widgets are not updated with target position but commands are sent to the rotator and current position is read back. This mode can be used to manually control your rotator.

Table 7.3: Operating modes of the rotator controller.

8 Creating Custom Layouts

Custom layouts are created by specifying the layout string manually. The layout string is a sequence of numbers separated with semicolon (;) and containing five numbers for each view that you want to appear in the layout.

The first number in each group of five specifies the module type:

- 0 – List view
- 1 – Map view
- 2 – Polar view
- 3 – Single Satellite view
- 4 – Upcoming Passes view

The remaining four numbers in the group of five specify the coordinates of the view in an invisible grid. The size of the grid is dynamic in the sense that it is determined at runtime according to the coordinates in the layout string.

The coordinate system in the layout grid has its origin (0,0) in the upper left corner, see figure 8.1. The coordinates for a view are specified using a LEFT, RIGHT, TOP, BOTTOM sequence.

Thus, if we want to place a map view in the upper 2/3 part of the grid on figure 8.1 the complete 5-digit sequence would be:
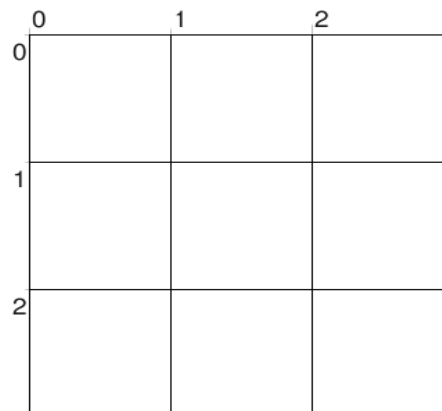
Figure 8.1: A 3x3 layout grid.

```
1;0;3;0;2
```

This is interpreted as *"Place a map view in the grid with top-left coordinate at (0,0) and bottom-right coordinate at (3,2)"*.

Similarly, to put list view in the lower 1/3 part of the grid, the sequence would be:

```
0;0;2;2;3
```

The complete sequence would end up being:

```
1;0;3;0;2;0;0;2;2;3
```

The order in which the views are specified doesn't matter. The complete sequence above would generate a layout that looks like the one on figure 8.2 below.
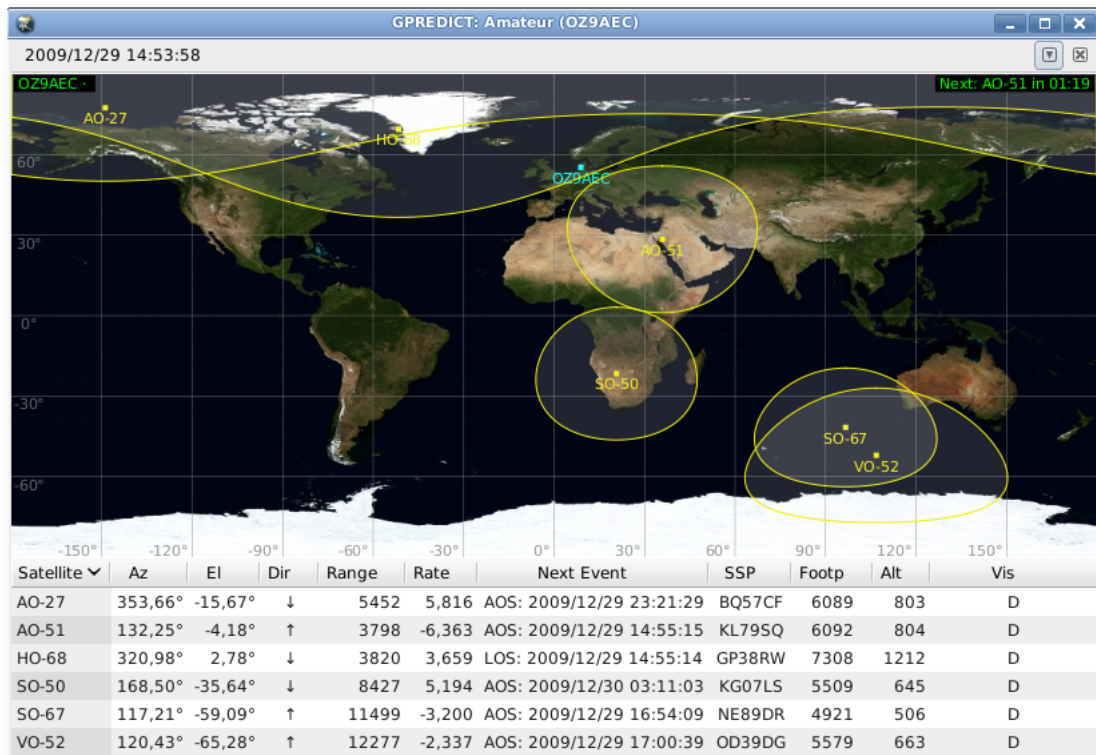

Figure 8.2: The layout generated by the sequence 1;0;3;0;2;0;0;2;2;3

This layout is included as one of the predefined layouts and you can use this and the other predefined layouts as examples.

9 Glossary

Term	Meaning
AOS	Acquisition of signal – the time when the satellite comes within range.
Az	Azimuth – the angle in the horizontal plane (tangential plane to the surface of Earth) relative to North with positive direction towards East.
CAT	Computer aided transmission. A term often used when a computer controls a communication radio device.
El	Elevation – the vertical angle between a vector pointing toward the horizon and a vector pointing towards a satellite. The horizon is 0° and zenith is 90°.
Full-duplex	A communication device/radio where tranmission and reception can occur at the same time
Hamlib	Ham Radio Control Libraries, see http://hamlib.sourceforge.net.
LO	Local oscillator. In Gpredict it is used to specify the frequency offset introduced by using a transverter.
LOS	Loss of signal – the time when a satellite goes out of range.
PTT	Push to talk.
RX	Receiver.
TCA	Time of closes approach – the time when the distance to a satellite is shortest.
TLE	Term used for the data files that contain Keplerian elements for a satellite orbit.
TRX	Transceiver.
TX	Transmitter